**PROTECCION TECNICA ECOLOGICA (PROTECO) INC.**
**PART B PERMIT APPLICATION**
**PRD 091018622**
**PENUELAS, PUERTO RICO**

VOLUME I

PRD 091 018622

Fred C. Hart Associates, Inc.

PRD091018622

PROTECCION TECNICA ECOLOGICA (PROTECO) INC.
PART B PERMIT APPLICATION
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VOLUME I

PRD 091 018622

# MATERIAL TO BE SUBMITTED

## PROTECO PART B

Surface Impoundment Design Drawings and Specifications

Emergency Coordinator Authorization Letter

Copy of Part A with Correct Signatures

Surveyed Boundaries of PROTECO Property

Right of Way Documentation for Power Lines

Statement in Deed of Hazardous Waste Land Disposal On-Site

Letter of Certification (Section K)

REVISED PART A

(fill—in areas are spaced for elite type, i.e., 12 characters/inch)

Form Approved OMB No. 158-R0175

FORM 1 GENERAL

U.S. ENVIRONMENTAL PROTECTION AGENCY

# GENERAL INFORMATION

*Consolidated Permits Program*

*(Read the "General Instructions" before starting.)*

I. EPA I.D. NUMBER

F

LABEL ITEMS

I. EPA I.D. NUMBER

III. FACILITY NAME

V. FACILITY MAILING ADDRESS

VI. FACILITY LOCATION

PLEASE PLACE LABEL IN THIS SPACE

GENERAL INSTRUCTIONS

If a preprinted label has been provided, affi it in the designated space. Review the inform ation carefully; if any of it is incorrect, cro through it and enter the correct data in th appropriate fill—in area below. Also, if any the preprinted data is absent *(the area to th left of the label space lists the informatic that should appear)*, please provide it in th proper fill—in area(s) below. If the label complete and correct, you need not complet Items I, III, V, and VI *(except VI-B whic must be completed regardless)*. Complete a items if no label has been provided. Refer t the instructions for detailed item descric tions and for the legal authorizations unde which this data is collected.

## II. POLLUTANT CHARACTERISTICS

**INSTRUCTIONS:** Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold—faced terms.

| SPECIFIC QUESTIONS | YES | NO | FORM ATTACHED | SPECIFIC QUESTIONS | YES | NO | FORM ATTACHED |
|---|---|---|---|---|---|---|---|
| A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A) | | X | | B. Does or will this facility *(either existing or proposed)* include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B) | | X | |
| C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C) | | X | | D. Is this a proposed facility *(other than those described in A or B above)* which will result in a discharge to waters of the U.S.? (FORM 2D) | X | | |
| E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3) | X | | X | F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4) | | X | |
| G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4) | | X | | H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4) | | X | |
| I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5) | | X | | J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5) | | X | |

## III. NAME OF FACILITY

1 SKIP PROTECCION TECNICA ECOLOGICA, INC.

## IV. FACILITY CONTACT

| A. NAME & TITLE (last, first, & title) | B. PHONE (area code & no.) |
|---|---|
| 2 GAYA RAUL DIRECTOR OF OPERATIONS | |

## V. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX

3 FIRM DELIVERY

| B. CITY OR TOWN | C. STATE | D. ZIP CODE |
|---|---|---|
| 4 PONCE | PR | 00731 |

## VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER

5 ROAD 385 KM 35

B. COUNTY NAME

TALLABOA

| C. CITY OR TOWN | D. STATE | E. ZIP CODE | F. COUNTY CODE (if known) |
|---|---|---|---|
| 6 PENUELAS | PR | 00724 | |

VII. SIC CODES (4-digit, in order of priority)

| A. FIRST | | B. SECOND | |
|---|---|---|---|
| 7 7399 | (specify) Business Service (NEC) Waste Disposal | 7 8899 | (specify) Service (NEC) Landfill |
| **C. THIRD** | | **D. FOURTH** | |
| 7 | (specify) | 7 | (specify) |

VIII. OPERATOR INFORMATION

A. NAME

8 PROTECCION TECNICA ECOLOGICA, INC.

B. Is the name listed in Item VIII-A also the owner? ☒ YES ☐ NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)

F = FEDERAL M = PUBLIC (other than federal or state)
S = STATE O = OTHER (specify)
P = PRIVATE

P (specify)

D. PHONE (area code & no.)

A 809 837 2211

E. STREET OR P.O. BOX

ROAD 385 Km35

| F. CITY OR TOWN | G. STATE | H. ZIP CODE |
|---|---|---|
| B PENEULAS | PR | 00731 |

IX. INDIAN LAND

Is the facility located on Indian lands? ☐ YES ☒ NO

X. EXISTING ENVIRONMENTAL PERMITS

| A. NPDES (Discharges to Surface Water) | D. PSD (Air Emissions from Proposed Sources) | |
|---|---|---|
| 9 N | 9 P | |
| **B. UIC (Underground Injection of Fluids)** | **E. OTHER (specify)** | |
| 9 U | 9 RSP #5 | (specify) Quality Board |
| **C. RCRA (Hazardous Wastes)** | **E. OTHER (specify)** | |
| 9 R | 9 75-12-19-56 | (specify) Puerto Rico Planning Board |

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property bounderies. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS (provide a brief description)

Treatment, storage and disposal of hazardous and non-hazardous waste from various manufacturing plants and government in Puerto Rico.

XIII. CERTIFICATION (see instructions)

*I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.*

| A. NAME & OFFICIAL TITLE (type or print) | B. SIGNATURE | C. DATE SIGNED |
|---|---|---|
| Jorge J. Fernandez, President | | |

COMMENTS FOR OFFICIAL USE ONLY

C

FORM 3 RCRA

**EPA**

U.S. ENVIRONMENTAL PROTECTION AGENCY

# HAZARDOUS WASTE PERMIT APPLICATION

*Consolidated Permits Program*

*(This information is required under Section 3005 of RCRA.)*

Form Approved OMB No. 158-S80004

**I. EPA I.D. NUMBER**

F PRD091018622

## FOR OFFICIAL USE ONLY

| APPLICATION APPROVED | DATE RECEIVED (yr., mo., & day) | COMMENTS |
|---|---|---|
| | | |

## II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below *(mark one box only)* to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.

**A. FIRST APPLICATION** *(place an "X" below and provide the appropriate data)*

☐ 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

☐ 2. NEW FACILITY *(Complete item below.)*

C 8 | YR. | MO. | DAY | FOR EXISTING FACILITIES, PROVIDE THE DATE (yr., mo., & day) OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

YR. | MO. | DAY | FOR NEW FACILITIES PROVIDE THE DATE (yr., mo., & day) OPERATION BEGAN OR IS EXPECTED TO BEGIN

**B. REVISED APPLICATION** *(place an "X" below and complete Item I above)*

☒ 1. FACILITY HAS INTERIM STATUS

☐ 2. FACILITY HAS A RCRA PERMIT

## III. PROCESSES – CODES AND DESIGN CAPACITIES

**A. PROCESS CODE** – Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code*(s)* in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the form *(Item III-C)*.

**B. PROCESS DESIGN CAPACITY** – For each code entered in column A enter the capacity of the process.

1. AMOUNT – Enter the amount.
2. UNIT OF MEASURE – For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

| PROCESS | PROCESS CODE | APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY |
|---|---|---|
| **Storage:** | | |
| CONTAINER *(barrel, drum, etc.)* | S01 | GALLONS OR LITERS |
| TANK | S02 | GALLONS OR LITERS |
| WASTE PILE | S03 | CUBIC YARDS OR CUBIC METERS |
| SURFACE IMPOUNDMENT | S04 | GALLONS OR LITERS |
| **Disposal:** | | |
| INJECTION WELL | D79 | GALLONS OR LITERS |
| LANDFILL | D80 | ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER |
| LAND APPLICATION | D81 | ACRES OR HECTARES |
| OCEAN DISPOSAL | D82 | GALLONS PER DAY OR LITERS PER DAY |
| SURFACE IMPOUNDMENT | D83 | GALLONS OR LITERS |
| **Treatment:** | | |
| TANK | T01 | GALLONS PER DAY OR LITERS PER DAY |
| SURFACE IMPOUNDMENT | T02 | GALLONS PER DAY OR LITERS PER DAY |
| INCINERATOR | T03 | TONS PER HOUR OR METRIC TONS PER HOUR, GALLONS PER HOUR OR LITERS PER HOUR |
| OTHER *(Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Item III-C.)* | T04 | GALLONS PER DAY OR LITERS PER DAY |

| UNIT OF MEASURE | UNIT OF MEASURE CODE | UNIT OF MEASURE | UNIT OF MEASURE CODE | UNIT OF MEASURE | UNIT OF MEASURE CODE |
|---|---|---|---|---|---|
| GALLONS | G | LITERS PER DAY | V | ACRE-FEET | A |
| LITERS | L | TONS PER HOUR | D | HECTARE-METER | F |
| CUBIC YARDS | Y | METRIC TONS PER HOUR | W | ACRES | B |
| CUBIC METERS | C | GALLONS PER HOUR | E | HECTARES | Q |
| GALLONS PER DAY | U | LITERS PER HOUR | H | | |

**EXAMPLE FOR COMPLETING ITEM III** *(shown in line numbers X-1 and X-2 below)*: A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

C DUP | I

| LINE NUMBER | A. PROCESS CODE (from list above) | B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify) | 2. UNIT OF MEASURE (enter code) | FOR OFFICIAL USE ONLY | LINE NUMBER | A. PROCESS CODE (from list above) | B. PROCESS DESIGN CAPACITY 1. AMOUNT | 2. UNIT OF MEASURE (enter code) | FOR OFFICIAL USE ONLY |
|---|---|---|---|---|---|---|---|---|---|
| X-1 | S 0 2 | 600 | G | | 5 | T 0 4 | 216 CY/ DAY | | |
| X-2 | T 0 3 | 20 | E | | 6 | D 8 0 | 620 | A | |
| 1 | T 0 1 | 20,000 | U | | 7 | S 0 4 | 289,500 | G | |
| 2 | S 0 1 | 84,480 | G | | 8 | | | | |
| 3 | S 0 2 | 164,000 | G | | 9 | | | | |
| 4 | T 0 2 | 10,000 | U | | 10 | | | | |

## III. PROCESSES *continued*

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESSES (code "T04") FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

T 04 Stabilization/fixation process (216 CY/DAY Output Rating)

## IV. DESCRIPTION OF HAZARDOUS WASTES

**A. EPA HAZARDOUS WASTE NUMBER** — Enter the four–digit number from 40 CFR, Subpart D for each listed hazardous waste you will handle. If you handle hazardous wastes which are not listed in 40 CFR, Subpart D, enter the four–digit number*(s)* from 40 CFR, Subpart C that describes the characteristics and/or the toxic contaminants of those hazardous wastes.

**B. ESTIMATED ANNUAL QUANTITY** — For each **listed waste** entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each **characteristic** or **toxic contaminant** entered in column A estimate the total annual quantity of all the non–listed waste*(s)* that will be handled which possess that characteristic or contaminant.

**C. UNIT OF MEASURE** — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

| ENGLISH UNIT OF MEASURE | CODE | METRIC UNIT OF MEASURE | CODE |
|---|---|---|---|
| POUNDS | P | KILOGRAMS | K |
| TONS | T | METRIC TONS | M |

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

**D. PROCESSES**

1. PROCESS CODES:

**For listed hazardous waste:** For each **listed** hazardous waste entered in column A select the code*(s)* from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

**For non–listed hazardous wastes:** For each characteristic or toxic contaminant entered in column A, select the code*(s)* from the list of process codes contained in Item III to indicate **all** the processes that will be used to store, treat, and/or dispose of all the non–listed hazardous wastes that possess that characteristic or toxic contaminant.

**Note:** Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code*(s)*.

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

**NOTE: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER** — Hazardous wastes that can be described by more than one EPA Hazardous Waste Number shall be described on the form as follows:

1. Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B,C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

**EXAMPLE FOR COMPLETING ITEM IV** *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non–listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

| LINE NO. | A. EPA HAZARD. WASTE NO *(enter code)* | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE *(enter code)* | D. PROCESSES 1. PROCESS CODES *(enter)* | D. PROCESSES 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))* |
|---|---|---|---|---|---|
| X-1 | K 0 5 4 | 900 | P | T 0 3 D 8 0 | |
| X-2 | D 0 0 2 | 400 | P | T 0 3 D 8 0 | |
| X-3 | D 0 0 1 | 100 | P | T 0 3 D 8 0 | |
| X-4 | D 0 0 2 | | | | *included with above* |


CONTINUE ON PAGE 3

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.

EPA I.D. NO. (enter from page 1)

| | T/A | C |
|---|---|---|
| F PRD091018622 | | 6 |

## V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail).*

## VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground—level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail).*

## VII. FACILITY GEOGRAPHIC LOCATION

| LATITUDE (degrees, minutes, & seconds) | LONGITUDE (degrees, minutes, & seconds) |
|---|---|
| 18 01 05 | 66 41 03 |

## VIII. FACILITY OWNER

☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

| 1. NAME OF FACILITY'S LEGAL OWNER | 2. PHONE NO. (area code & no.) |
|---|---|
| E Compania Ganadera del Sur, Inc. | 801-836-1086 |

| 3. STREET OR P.O. BOX | 4. CITY OR TOWN | 5. ST. | 6. ZIP CODE |
|---|---|---|---|
| F Firm Delivery | G Ponce | PR | 00731 |

## IX. OWNER CERTIFICATION

*I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.*

| A. NAME (print or type) | B. SIGNATURE | C. DATE SIGNED |
|---|---|---|
| Lucas P. Valdivieso | | |

## X. OPERATOR CERTIFICATION

*I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.*

| A. NAME (print or type) | B. SIGNATURE | C. DATE SIGNED |
|---|---|---|
| Jorge J. Fernandez | | |



CONTINUE ON PAGE 5

NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

Form Approved OMB No. 158-S80004

| EPA I.D. NUMBER (enter from page 1) | T/A | C | FOR OFFICIAL USE ONLY | T/A | C | |
|---|---|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | | 1 | W DUP | | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

| LINE NO. | A. EPA HAZARD. WASTE NO. *(enter code)* | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE *(enter code)* | D. PROCESSES 1. PROCESS CODES *(enter)* | | | | D. PROCESSES 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))* |
|---|---|---|---|---|---|---|---|---|
| 1 | D001 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | D002 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | D004 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | D005 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | D006 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | D007 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | D008 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | D009 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | D010 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | D011 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | D012 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | D013 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | D014 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | D015 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | D016 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | D017 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | F001 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | F002 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | F003 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | F004 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | F005 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | F006 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | F019 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | F024 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | K061 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | K062 | 100 | K | S01 | S02 | T04 | D80 | |

EPA Form 3510-3 (6-80)

CONTINUE ON REVERSE



*(enter "A", "B", "C", etc. behind the "3" to identify photocopied pages)*

NOTE: Photocopy this page before completing if you have more than 26 wastes to list. Form Approved OMB No. 158-S80004

EPA I.D. NUMBER (enter from page 1): W P R D 0 9 1 0 1 8 6 2 2 — 1

FOR OFFICIAL USE ONLY: W DUP 2 DUP

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | K069 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | K100 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | K084 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | K101 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | K102 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | K086 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | K002 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | K003 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | K004 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | K005 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | K005 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | K006 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | K007 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | K008 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | K009 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | K010 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | K014 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | K015 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | K016 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | K017 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | K018 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | K019 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | K020 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | K021 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | K022 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | K023 | 100 | K | S01 | S02 | T04 | D80 | |

EPA Form 3510-3 (6-80) CONTINUE ON REVERSE

NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

Form Approved OMB No. 158-S80004

EPA I.D. NUMBER (enter from page 1): W P R D 0 9 1 0 1 8 6 2 2 — T/A C: 1

FOR OFFICIAL USE ONLY: W — DUP — T/A C: 2 — DUP

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|
| 1 | K024 | 100 | K | S01 S02 T04 D80 | |
| 2 | K093 | 100 | K | S01 S02 T04 D80 | |
| 3 | K094 | 100 | K | S01 S02 T04 D80 | |
| 4 | K025 | 100 | K | S01 S02 T04 D80 | |
| 5 | K026 | 100 | K | S01 S02 T04 D80 | |
| 6 | K028 | 100 | K | S01 S02 T04 D80 | |
| 7 | K029 | 100 | K | S01 S02 T04 D80 | |
| 8 | K095 | 100 | K | S01 S02 T04 D80 | |
| 9 | K096 | 100 | K | S01 S02 T04 D80 | |
| 10 | K030 | 100 | K | S01 S02 T04 D80 | |
| 11 | K083 | 100 | K | S01 S02 T04 D80 | |
| 12 | K103 | 100 | K | S01 S02 T04 D80 | |
| 13 | K085 | 100 | K | S01 S02 T04 D80 | |
| 14 | K105 | 100 | K | S01 S02 T04 D80 | |
| 15 | K071 | 100 | K | S01 S02 T04 D80 | |
| 16 | K073 | 100 | K | S01 S02 T04 D80 | |
| 17 | K106 | 100 | K | S01 S02 T04 D80 | |
| 18 | K031 | 100 | K | S01 S02 T04 D80 | |
| 19 | K032 | 100 | K | S01 S02 T04 D80 | |
| 20 | K033 | 100 | K | S01 S02 T04 D80 | |
| 21 | K034 | 100 | K | S01 S02 T04 D80 | |
| 22 | K097 | 100 | K | S01 S02 T04 D80 | |
| 23 | K048 | 100 | K | S01 S02 T04 D80 | |
| 24 | K049 | 100 | K | S01 S02 T04 D80 | |
| 25 | K050 | 100 | K | S01 S02 T04 D80 | |
| 26 | K051 | 100 | K | S01 S02 T04 D80 | |

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CONTINUE ON REVERSE

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Form Approved OMB No. 158-S80004

| EPA I.D. NUMBER (enter from page 1) | T/A | C |
|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | | 1 |

| FOR OFFICIAL USE ONLY | | | |
|---|---|---|---|
| W DUP | | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | K052 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U001 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U002 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U003 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U004 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U005 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U007 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U008 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U009 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U010 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U011 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U012 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U014 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U015 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U016 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U017 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U018 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U020 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U021 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U024 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U025 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U037 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U038 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U029 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U034 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | U049 | 100 | K | S01 | S02 | T04 | D80 | |

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Form Approved OMB No. 158-S80004

EPA I.D. NUMBER (enter from page 1): W P R D 0 9 1 0 1 8 6 2 2 — T/A C: 1

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## IV. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | U030 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U025 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U028 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U023 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U022 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U036 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U026 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U043 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U042 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U045 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U046 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U047 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U044 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U059 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U055 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U058 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U056 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U067 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U068 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U069 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U063 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U070 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U071 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U072 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U073 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | U074 | 100 | K | S01 | S02 | T04 | D80 | |

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Form Approved OMB No. 158-S80004

| EPA I.D. NUMBER (enter from page 1) | T/A C | FOR OFFICIAL USE ONLY | | T/A C | |
|---|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | 1 | W | DUP | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | U075 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U076 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U078 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U079 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U077 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U082 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U089 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U080 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U083 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U088 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U084 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U086 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U085 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U081 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U087 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U064 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U066 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U062 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U060 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U061 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U093 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U090 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U098 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U099 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U092 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | U094 | 100 | K | S01 | S02 | T04 | D80 | |

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| EPA I.D. NUMBER (enter from page 1) | T/A C | FOR OFFICIAL USE ONLY | T/A C | |
|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | 1 | W DUP | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | U091 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U106 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U105 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U102 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U107 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U109 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U111 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U112 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U113 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U114 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U115 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U116 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U117 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U118 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U119 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U120 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U121 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U122 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U123 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U124 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U108 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U101 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U103 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U108 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U110 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | | 100 | K | S01 | S02 | T04 | D80 | |

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| EPA I.D. NUMBER (enter from page 1) | T/A | C | FOR OFFICIAL USE ONLY | T/A | C | |
|---|---|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | | 1 | W DUP | | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

| LINE NO. | A. EPA HAZARD. WASTE NO. *(enter code)* | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE *(enter code)* | D. PROCESSES 1. PROCESS CODES *(enter)* | | | | 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))* |
|---|---|---|---|---|---|---|---|---|
| 1 | U125 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U126 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U127 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U128 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U129 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U130 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U131 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U132 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U134 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U138 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U139 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U140 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U141 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U142 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U143 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U144 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U145 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U146 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U147 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U148 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U149 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U150 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U151 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U152 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U153 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | U154 | 100 | K | S01 | S02 | T04 | D80 | |

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| EPA I.D. NUMBER (enter from page 1) | T/A | C | FOR OFFICIAL USE ONLY | T/A | C | |
|---|---|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | | 1 | W DUP | | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | U155 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U156 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U157 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U158 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U159 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U161 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U162 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U163 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U164 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U165 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U166 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U167 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U168 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U169 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U170 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U171 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U172 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U173 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U174 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U175 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U177 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U178 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U179 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U180 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U181 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | U182 | 100 | K | S01 | S02 | T04 | D80 | |

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| EPA I.D. NUMBER (enter from page 1) | FOR OFFICIAL USE ONLY | | |
|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 1 | W DUP | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|
| 1 | U183 | 100 | K | S01 S02 T04 D80 | |
| 2 | U184 | 100 | K | S01 S02 T04 D80 | |
| 3 | U185 | 100 | K | S01 S02 T04 D80 | |
| 4 | U187 | 100 | K | S01 S02 T04 D80 | |
| 5 | U188 | 100 | K | S01 S02 T04 D80 | |
| 6 | U186 | 100 | K | S01 S02 T04 D80 | |
| 7 | U190 | 100 | K | S01 S02 T04 D80 | |
| 8 | U197 | 100 | K | S01 S02 T04 D80 | |
| 9 | U193 | 100 | K | S01 S02 T04 D80 | |
| 10 | U192 | 100 | K | S01 S02 T04 D80 | |
| 11 | U200 | 100 | K | S01 S02 T04 D80 | |
| 12 | U201 | 100 | K | S01 S02 T04 D80 | |
| 13 | U202 | 100 | K | S01 S02 T04 D80 | |
| 14 | U206 | 100 | K | S01 S02 T04 D80 | |
| 15 | U207 | 100 | K | S01 S02 T04 D80 | |
| 16 | U208 | 100 | K | S01 S02 T04 D80 | |
| 17 | U203 | 100 | K | S01 S02 T04 D80 | |
| 18 | U209 | 100 | K | S01 S02 T04 D80 | |
| 19 | U210 | 100 | K | S01 S02 T04 D80 | |
| 20 | U218 | 100 | K | S01 S02 T04 D80 | |
| 21 | U213 | 100 | K | S01 S02 T04 D80 | |
| 22 | U211 | 100 | K | S01 S02 T04 D80 | |
| 23 | U214 | 100 | K | S01 S02 T04 D80 | |
| 24 | U220 | 100 | K | S01 S02 T04 D80 | |
| 25 | U225 | 100 | K | S01 S02 T04 D80 | |
| 26 | U226 | 100 | K | S01 S02 T04 D80 | |

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| EPA I.D. NUMBER (enter from page 1) | T/A C | FOR OFFICIAL USE ONLY | T/A C | |
|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | 1 | W DUP | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | | | | 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|---|---|---|
| 1 | U223 | 100 | K | S01 | S02 | T04 | D80 | |
| 2 | U227 | 100 | K | S01 | S02 | T04 | D80 | |
| 3 | U222 | 100 | K | S01 | S02 | T04 | D80 | |
| 4 | U235 | 100 | K | S01 | S02 | T04 | D80 | |
| 5 | U234 | 100 | K | S01 | S02 | T04 | D80 | |
| 6 | U236 | 100 | K | S01 | S02 | T04 | D80 | |
| 7 | U238 | 100 | K | S01 | S02 | T04 | D80 | |
| 8 | U239 | 100 | K | S01 | S02 | T04 | D80 | |
| 9 | U237 | 100 | K | S01 | S02 | T04 | D80 | |
| 10 | U243 | 100 | K | S01 | S02 | T04 | D80 | |
| 11 | U247 | 100 | K | S01 | S02 | T04 | D80 | |
| 12 | U248 | 100 | K | S01 | S02 | T04 | D80 | |
| 13 | U249 | 100 | K | S01 | S02 | T04 | D80 | |
| 14 | U213 | 100 | K | S01 | S02 | T04 | D80 | |
| 15 | U216 | 100 | K | S01 | S02 | T04 | D80 | |
| 16 | U217 | 100 | K | S01 | S02 | T04 | D80 | |
| 17 | U219 | 100 | K | S01 | S02 | T04 | D80 | |
| 18 | U218 | 100 | K | S01 | S02 | T04 | D80 | |
| 19 | U221 | 100 | K | S01 | S02 | T04 | D80 | |
| 20 | U228 | 100 | K | S01 | S02 | T04 | D80 | |
| 21 | U227 | 100 | K | S01 | S02 | T04 | D80 | |
| 22 | U231 | 100 | K | S01 | S02 | T04 | D80 | |
| 23 | U232 | 100 | K | S01 | S02 | T04 | D80 | |
| 24 | U230 | 100 | K | S01 | S02 | T04 | D80 | |
| 25 | U244 | 100 | K | S01 | S02 | T04 | D80 | |
| 26 | U240 | 100 | K | S01 | S02 | T04 | D80 | |

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Form Approved OMB No. 158-S80004

EPA I.D. NUMBER (enter from page 1): W PRD091018622 | T/A C: 1

FOR OFFICIAL USE ONLY: W DUP | T/A C: 2 | DUP

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|
| 1 | P016 | 100 | K | S01 S02 T04 D80 | |
| 2 | P017 | 100 | K | S01 S02 T04 D80 | |
| 3 | P123 | 100 | K | S01 S02 T04 D80 | |
| 4 | P103 | 100 | K | S01 S02 T04 D80 | |
| 5 | P025 | 100 | K | S01 S02 T04 D80 | |
| 6 | P026 | 100 | K | S01 S02 T04 D80 | |
| 7 | P027 | 100 | K | S01 S02 T04 D80 | |
| 8 | P036 | 100 | K | S01 S02 T04 D80 | |
| 9 | P037 | 100 | K | S01 S02 T04 D80 | |
| 10 | P039 | 100 | K | S01 S02 T04 D80 | |
| 11 | P041 | 100 | K | S01 S02 T04 D80 | |
| 12 | P040 | 100 | K | S01 S02 T04 D80 | |
| 13 | P043 | 100 | K | S01 S02 T04 D80 | |
| 14 | P044 | 100 | K | S01 S02 T04 D80 | |
| 15 | P045 | 100 | K | S01 S02 T04 D80 | |
| 16 | U019 | 100 | K | S01 S02 T04 D80 | |
| 17 | U095 | 100 | K | S01 S02 T04 D80 | |
| 18 | U097 | 100 | K | S01 S02 T04 D80 | |
| 19 | U212 | 100 | K | S01 S02 T04 D80 | |
| 20 | | 100 | K | S01 S02 T04 D80 | |
| 21 | | 100 | K | S01 S02 T04 D80 | |
| 22 | | 100 | K | S01 S02 T04 D80 | |
| 23 | | 100 | K | S01 S02 T04 D80 | |
| 24 | | 100 | K | S01 S02 T04 D80 | |
| 25 | | 100 | K | S01 S02 T04 D80 | |
| 26 | | 100 | K | S01 S02 T04 D80 | |

EPA Form 3510-3 (6-80)

CONTINUE ON REVERSE

NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

Form Approved OMB No. 158-S80004

| EPA I.D. NUMBER (enter from page 1) | T/A | C | FOR OFFICIAL USE ONLY | T/A | C | |
|---|---|---|---|---|---|---|
| W P R D 0 9 1 0 1 8 6 2 2 | | 1 | W DUP | | 2 | DUP |

## IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

| LINE NO. | A. EPA HAZARD. WASTE NO. (enter code) | B. ESTIMATED ANNUAL QUANTITY OF WASTE | C. UNIT OF MEASURE (enter code) | D. PROCESSES 1. PROCESS CODES (enter) | 2. PROCESS DESCRIPTION (if a code is not entered in D(1)) |
|---|---|---|---|---|---|
| 1 | P023 | 100 | K | S01 S02 T04 D80 | |
| 2 | P002 | 100 | K | S01 S02 T04 D80 | |
| 3 | P057 | 100 | K | S01 S02 T04 D80 | |
| 4 | P058 | 100 | K | S01 S02 T04 D80 | |
| 5 | P066 | 100 | K | S01 S02 T04 D80 | |
| 6 | P001 | 100 | K | S01 S02 T04 D80 | |
| 7 | P002 | 100 | K | S01 S02 T04 D80 | |
| 8 | P003 | 100 | K | S01 S02 T04 D80 | |
| 9 | P070 | 100 | K | S01 S02 T04 D80 | |
| 10 | P004 | 100 | K | S01 S02 T04 D80 | |
| 11 | P005 | 100 | K | S01 S02 T04 D80 | |
| 12 | P006 | 100 | K | S01 S02 T04 D80 | |
| 13 | P007 | 100 | K | S01 S02 T04 D80 | |
| 14 | P008 | 100 | K | S01 S02 T04 D80 | |
| 15 | P119 | 100 | K | S01 S02 T04 D80 | |
| 16 | P010 | 100 | K | S01 S02 T04 D80 | |
| 17 | P012 | 100 | K | S01 S02 T04 D80 | |
| 18 | P011 | 100 | K | S01 S02 T04 D80 | |
| 19 | P012 | 100 | K | S01 S02 T04 D80 | |
| 20 | P038 | 100 | K | S01 S02 T04 D80 | |
| 21 | P024 | 100 | K | S01 S02 T04 D80 | |
| 22 | P077 | 100 | K | S01 S02 T04 D80 | |
| 23 | P028 | 100 | K | S01 S02 T04 D80 | |
| 24 | P042 | 100 | K | S01 S02 T04 D80 | |
| 25 | P014 | 100 | K | S01 S02 T04 D80 | |
| 26 | P015 | 100 | K | S01 S02 T04 D80 | |

EPA Form 3510-3 (6-80)

CONTINUE ON REVERSE

# SECTION 8 - FACILITY DESCRIPTION

# SECTION B

## FACILITY DESCRIPTION

This section provides a general description of the hazardous waste management facility operated by PROTECO , a topographic map of the present facility and proposed extensions, and facility location and traffic pattern information. This description is intended to acquaint the permit application reviewer with an overview of the facility. More complete details can be found in other parts of this permit application. This information is submitted in accordance with 40 CFR 270.14(b)(1), (10), (11), (19) and the Puerto Rico Environmental Quality Board's Regulations for the Control of Hazardous and Non-Hazardous Solid Wastes, Part IX, Rule 902.

### B-1 General Description [40 CFR 270.14(b)(1)]

The mailing address is:

Proteccion Tecnica Ecologica
Firm Delivery
Ponce, Puerto Rico 00731

The activities conducted at the PROTECO hazardous waste management facility include the treatment, storage and disposal of hazardous waste and the treatment and disposal of non-hazardous waste. The hazardous wastes received and accepted at the facility are generated from many diverse manufacturing operations located in the Commonwealth of Puerto Rico. The hazardous waste is transported from these generators to the facility primarily by the PROTECO transportation staff. Table B-1 lists many of the types of industries served by PROTECO, the products they produce and the hazardous wastes generated from the manufacture of these products.

Two methods are currently used to treat the hazardous wastes accepted for treatment, storage and disposal to render the wastes less hazardous, non-hazardous, stabilized and/or more amenable to disposal. The primary method used is stabilization/fixation. This treatment procedure renders a waste to a concrete-like solid material by reacting lime, fly ash, cement kiln dust, water and waste to form the solid. These treatment methods are discussed in more detail in the following sections. PROTECO also employs neutralization processes. Neutralization is a common treatment practice used to adjust the pH of a waste to an acceptable pH level (6.0 to 9.0) by combining acidic and alkaline materials.

Figure B-1 locates the proposed treatment, storage and disposal sites at the PROTECO facility. The proposed tank farm consists of the following hazardous waste management units:

- Seven aboveground storage tanks, ID Nos. T1, T2, T4, T5, T6, T7 and T8,
- One aboveground treatment (neutralization) tank, ID. No. T3.

The facility accepts a wide range of hazardous wastes. PROTECO treats, stores and disposes of those wastes that are liquid, solid, sludges or slurries. Both characteristic and listed hazardous wastes as defined by 40 CFR 261 are accepted for treatment, storage and disposal. These include but are not limited to:

- Ignitable wastes
- Corrosive waste
- EP toxic wastes
- Halogenated solvents
- Pesticide waste
- Electroplating sludges

## SUMMARY OF PROPOSED DISPOSAL PRACTICES AT SCI

### STORAGE FACILITIES

Container Storage Facility

Surface Impoundments

Tanks

- T-1 Alkali Tank
- T-2 Acid Tank
- T-4 Halogenated Solvents Tank
- T-5 Non-Halogenated Solvents Tank
- T-6 Oil Sludge Tank
- T-7 Aqueous Tank
- T-8 Oils Tank

### Treatment Facilities

Tank

- T-3 Neutralization Tank

Stabilization/Fixation Unit

### Disposal Facilities

Landfill I

Landfill II

## B-2 Topographic Map [40 CFR 270.14(bl(19)]

Figure B-2 is a topographic map of the hazardous waste facility. This map provides a layout of the facility with relief greater than 6.1 meters (20 feet), for which the regulation normally seeks a 1.5 meter (5 feet) contour interval. The regulation also suggests that the owner of facilities located in mountainous areas should use a larger contour interval. At this site the relief is 50 meters (164 feet) and the contour interval of two feet has been chosen to clearly show the pattern of surface water flow in the vicinity of and from each operational unit of the facility. Four foot contours are provided in steeper areas surrounding the waste management area due to sharply rising topographical relief.

### B-2a Map Scale and Date

Figure B-2 identifies the location of proposed facilities at the PROTECO site. Figure B-2 is provided with a scale of 1 to 1,200 (one inch to 100 feet) from base topography developed in August 9, 1984. A map scale of 1 to not more than 2400 (one inch to 200 feet) is required by the regulation. Figure B-3 provides additional topographical information to fulfill regulatory requirements calling for coverage 1,000 feet around the site. Figure B-3 is also provided with a scale of 1 to 1,200 from the same base topography.

### B-2b 100-Year Floodplain Are

The Tallaboa River and its tributaries originate on the southern slope of the Central Cordillera and flow southward into the Tallaboa Bay. The Lower Tallaboa Valley, for approximately four miles, is entrenched and confined by rugged upland that borders both the east and west flanks of the valley. The steep bluff rises steeply over forty meters from the adjacent relatively flat river valley. Thus, flood waters, even the 100 year flood plain, remain confined or restricted to the entrenched valley proper and some of the indented ravines along the cliff's flanks. Carbareon's facilities are located 70 meters above the maximum water level a 100 year flood could generate (Figure B-4).

B-2c Surface Water

Presently a small natural channel carved by an intermittent brook drains the area only during extraordinary rainfall. No perennial flow exists, otherwise, along this channel which lies on a topographical lower level from the main facilities. The main drainage channel is 3 feet wide and 2 feet deep at its maximum and it is entrenched in case hardened surface of calcareous material located outside of PROTECO's property. The channel runs from northeast to southwest along near the site and ultimately drains into the Rio Tallaboa.

A surface water management project has been designed to control any surface flows over and around the site. Calculations used in developing this system are given in Appendix D-6.4.

B-2d Land Use

The land surrounding the site is primarily unused due to the remote location and steep terrain. Grazing of a "cebu" breed cattle takes place on a limited scale in areas located 2,000 - 3,000 meters southeast of the site. The scant rainfall and rugged calcereous geological setting has precluded agricultural activity in the region. There are no man made structures for over 1000 meters in any direction except for electric power transmission lines which cross the north end of Parcel B. There are also no permanent residences for over 2.3 kilometers in any direction. Because of the rugged and inhospitable terrain there are no plans for land development in the vicinity of the site.

FIGURE B-2R

TOPO MAP

The topographic map can be found in a pocket at the end of this report.

FIGURE B-3

1 and 2 of 2

This topographic map can be found in a map pocket at the end of RCRA Part B Permit Application Appendices Volume 1

On the other hand, the favorable coastal geographical and topographical location along the lower reaches of the Tallaboa Valley, together with the natural harbor existing adjacent to these coastal reaches, have made the area desirable for petrochemical complexes, power generating plant and allied industries. PROTECO's waste-management site is located 3.5 kilometers north of the Caribbean seashore and 2.5 kilometers immediately east of the Tallaboa River Valley (as noted in Figure B-5).

B-2e Wind Rose

Figure B-6 shows the annual average prevailing windspeed and direction. This figure indicates that approximately 70 percent of the annual wind is in an easterly direction, away from the closest communities (Seboro and Tallaboa).

B-2f Orientation

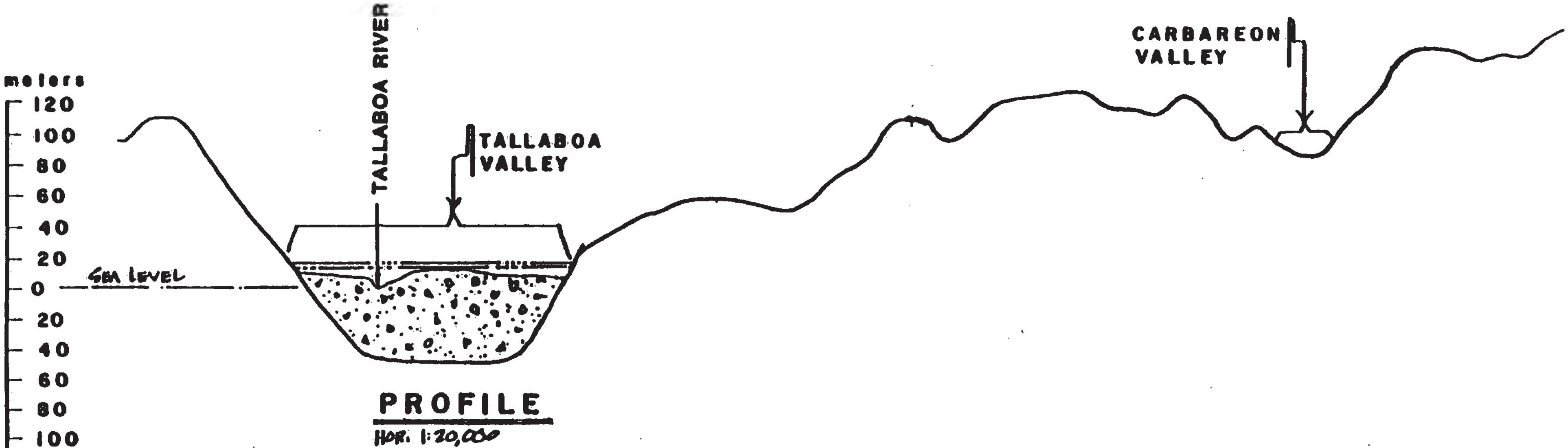
The north arrow is shown on the map, Figure B-2.

B-2g Legal Boundaries

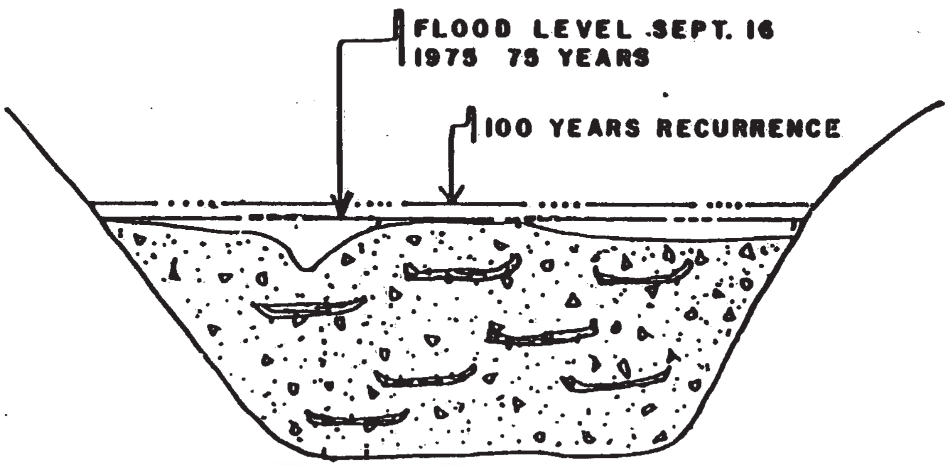
The PROTECO facility is presently being surveyed to establish the legal boundaries of all hazardous waste units and operations. The results of this survey will be submitted to the USEPA and the EQB as Addendum B-1 to this Part B upon finalization.

B-2h Access Control

The facility is surrounded by fences and/or natural barriers. Access control is discussed in further detail in Section F-1. Only one road, whose access is controlled, connects the facilities with major highways. The confinement and isolation of the site is more accentuated by the fact that the inner valley is surrounded by high-relief steep-sloping hills which are fully covered with xerophilous vegetation all year round. This inhospitable topographical setting and vegetative growth acts also as a natural barrier.




**PROFILE**
HOR. 1:20,000




**DETAIL FLOOD LEVEL AT TALLABOA RIVER VALLEY SAME LATITUDE OF CARBAREON SITE**
V: HORZ. 1:10,000

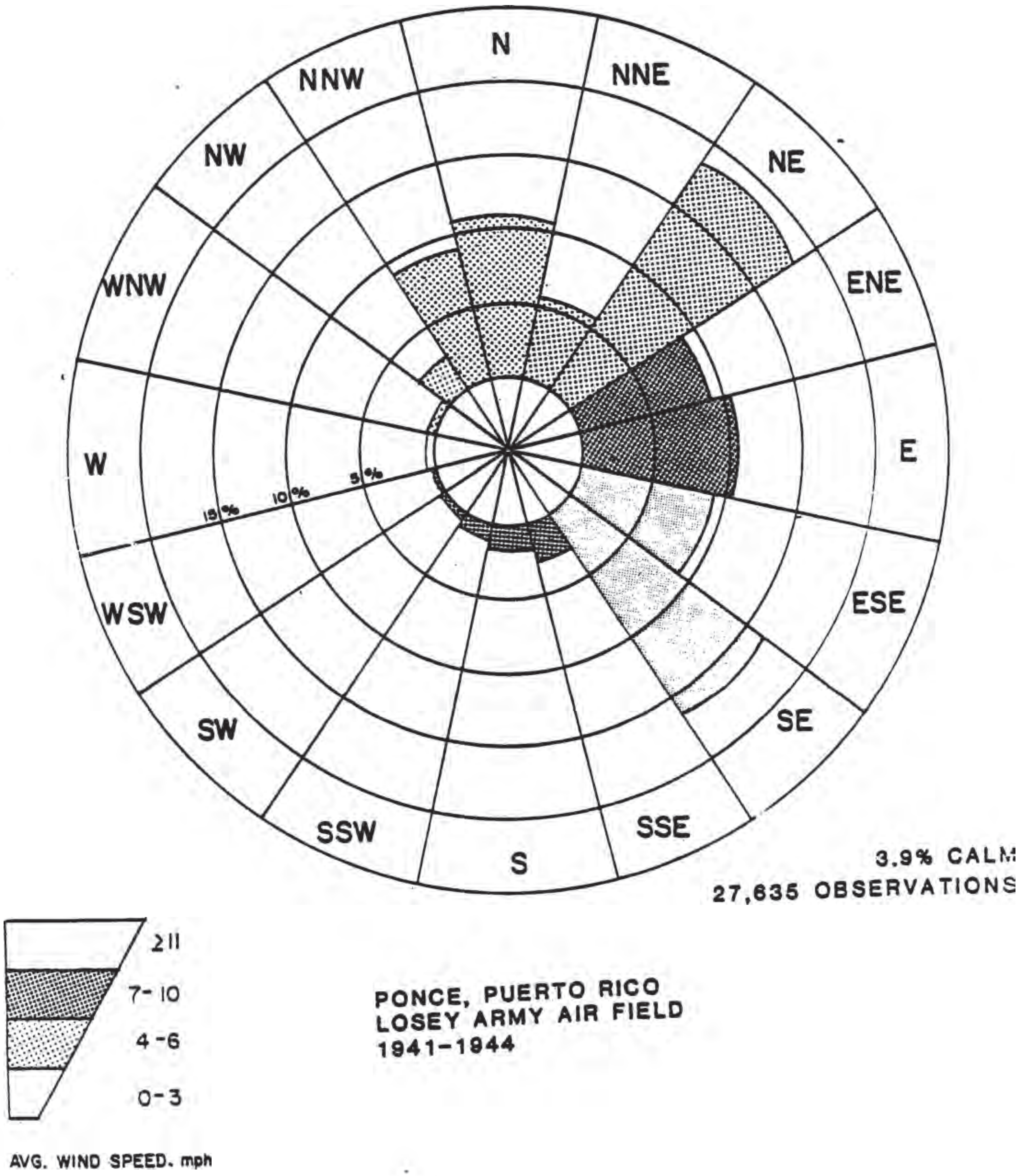
**SOURCE:**
FLOOD OF SEPT. 16, 1975
TALLABOA VALLEY, P.R.
U.S. GEOLOGICAL SURVEY-
WATER BRANCH 19
NO.____

FIGURF B-4

FIGURE B-6

WIND ROSE

SHOWING AVERAGE ANNUAL WINDSPEED AND DIRECTION




PONCE, PUERTO RICO
LOSEY ARMY AIR FIELD
1941-1944

A new chain-link fence with a electric gate at the only entrance to the facility is shown in Figure B-2. In addition, the stabilization/ fixation unit, the container storage facility and the tank storage/treatment unit are surrounded by a six foot chain link fence. A three-strand barbed wire fence traces the remainder of the property line.

B-2i Injection and Withdrawal Wells

The site has no injection wells. There are monitoring wells on the site which are not used for the withdrawal of water. There are no injection wells, and there are no withdrawal wells off-site within 305 m (1000 feet) of the facility.

B-2j Proposed Buildings, Treatment, Storage or Disposal Operations

Planned structures are shown on Figure B-1

Treatment, Storage and Disposal Operations. The proposed tank storage area is shown on Figure B-1. Locations of the proposed landfills are also shown on Figure B-3. Engineering drawings for the Container Storage Facility, Tank Storage/Treatment Area, and Landfills I and II have been submitted to the EPA.

Runoff Control Systems.

Access and internal roads.

Sewers. None are proposed.

Loading and Unloading Areas. A concrete loading/unloading hardstand is provided at the Container Storage Facility. Other loading and unloading areas are located on Figure B-1.

Fire Control Facilities. PROTECO will upgrade present fire control programs.

B-2k Flood Control/Drainage Barrier

The size of the watershed at this site is too small to expect flood damage to occur. This is discussed further in Section B-3. If needed, there is a capability to pump water from the oil lagoon into the rain water lagoon.

B-2l Location of Operational Units

The location of all TSD facilities are shown on the map, Figure B-2.

## B-3 Location Information [40 CFR 270.14(b)(11)]

B-3a Seismic Standard [40 CFR 270.14(b)(11)(i) and (ii)]

Because this facility is not listed in Appendix VI of Part 264, no further information is required to demonstrate compliance with §264.18(a). Seismic activity in this area is not significant for the purposes of this permit.

B-3b Floodplain Standard [40 CFR 270.14(b)(11)(iii)]

This facility is not located within a 100-year floodplain. The facility is in Zone 'c', Not Floodable. The source of information is the Flood Insurance Rate Map for Puerto Rico, Community Panel Number 720000, Panel 0218B effective July 2, 1981.

## B-4 Traffic Patterns [40 CFR 270.14(b)(10)]

Access to Servicios Carbareon, Inc. (PROTECO) is from P.R. 2 to P.R. 385 to the private access road leading directly to the site as shown in Figure B-6. P.R. 2 is a four-lane, all weather, hard surface, primary highway. The P.R. 2/P.R. 385 intersection is a modified cloverleaf, from which there is immediate (less than 0.8 Km or 0.5 mi) access to the private entrance road. The entrance road is approximately 3 KM in length to the main gate of the facility. The road bed is 8 m wide constructed of compacted selected material.

The access road traverses high quality road bed soil (AASHTO rating A-2) over half of its length. This Aquilita series stony clay loam is used as a source of roadfill because of the physical properties of the limestone. Although the existing access road design specifications are not recorded, the road successfully carries tractor-trailer vehicles, which have 40 ton gross weights, and 10,000 gallon capacity vacuum trucks.

The maximum anticipated loading condition on site roadways would result from a fully loaded 18 wheeler weighing approximately 82,000 pounds. This represents a load of 17 pounds per square inch on the road surface. Strength testing of the soils used for the roadways has shown that the soils have a minimum ultimate bearing capacity of 5250 psf, which will provide a factor of safety of 2 for anticipated wheel loads. These laboratory results compare favorably with empirical results based on penetration resistance (bearing capacity greater than 4000 psf). Also, the adequacy of the soils has also been established over the years by the ability of existing roadways to withstand repeated vehicle loads of the type and magnitude anticipated.

Normal traffic volume is one or two 40 ton trucks per day. A maximum of 13 trucks per day has been experienced in the past. Future anticipated traffic flow is estimated to be a maximum of 25 trucks per day.

All roads have the capability to allow the flow of traffic in both directions. Within the site, traffic vehicles consist of heavy equipment such as a bulldozer, front end loader, and excavator (back hoe). Tank trucks, suction trucks and tractor/trailers are used to move waste on-site.

Traffic Control. Stop signs will be used to control all return traffic flow from dead end roads. Stop signs will also control all traffic flow entering and leaving access/exit gates. In addition yellow painted cement highway markers are installed on roadways throughout the site.

## SECTION C - WASTE CHARACTERISTICS AND ANALYSIS PLAN

SECTION C

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SECTION C

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## SECTION C
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# SECTION C

## WASTE CHARACTERISTICS

This section describes the chemical and physical nature of the hazardous wastes treated, stored or disposed of at Proteccion Tecnica Ecologica, Inc. (PROTECO); the waste analysis plan for sampling, testing, and evaluating wastes to assure that sufficient information is available to treat, store and dispose of the waste; the screening and evaluation of each waste shipment before acceptance at the facility and the trial testing program for treatment of wastes by stabilization/fixation.

This section describes the proposed waste analysis program that is presently starting to be implemented by PROTECO. This information is submitted in accordance with the requirements of 40 CFR 270.14(b)(2) and (3) and the Puerto Rico Environmental Quality Board (EQB) Regulations, Part VIII - Rule 807I and Part IX - Rule 902D.

### C-1 Chemical and Physical Analyses [40 CFR 270.14(b)(2)]

#### C-1a General Disposition of Hazardous Wastes Treated, Stored or Disposed of at the Facility

Proposed facilities at PROTECO include a container storage facility, a tank storage area with eight tanks providing a total of 160,000 gallons of storage and treatment, and two new landfill facilities with a combined design capacity of approximately 1,000,000 cubic yards. A list of the wastes treated, stored or disposed of at the PROTECO facility and the basis for the hazard designation is presented in Table C-1.

Hazardous wastes accepted at PROTECO will be handled in one of four general methods: storage in a tank or containerized waste area, neutralization, stabilization/fixation and/or secure landfilling. The primary method used to treat wastes is stabilization/fixation. Typically, up to one half of all the waste streams received by the facility will be treated by this method.

TABLE C-1

WASTES, ASSOCIATED HAZARDS, AND BASIS FOR HAZARD DESIGNATION

| Hazardous Waste | Hazard | Basis for Hazard Designation |
|---|---|---|
| Ignitable wastes includes oil, kerosene, thinners, solvent mixtures, alcohols | Ignitable | Ignitable, all wastes have a flash point less than 140°F, flash points range between 0°F and 140°F. Listed waste D001. |
| Corrosive wastes includes NaOH, $H_2SO_4$ | Corrosive | Corrosive, wastes have a pH less than 2 or greater than 12.5. Listed waste D002. |
| Arsenic contaminated wastes | Toxic | EP Toxic, arsenic concentration greater than 5 ppm. Listed waste D004. |
| Cadmium contaminated wastes | Toxic | EP Toxic, cadmium concentration greater than 1 ppm. Listed waste D006. |
| Chromium contaminated wastes | Toxic | EP Toxic, chromium concentration greater than 5 ppm. Listed waste D007. |
| Lead contaminated wastes | Toxic | EP Toxic, lead concentration greater than 5 ppm. Listed waste D008. |
| Mercury contaminated wastes | Toxic | EP Toxic, mercury concentration greater than 0.2 ppm. Listed waste D009. |
| Selenium contaminated wastes | Toxic | EP Toxic, selenium concentration greater than 1 ppm. Listed waste D010. |
| Silver contaminated wastes | Toxic | EP Toxic, silver concentration greater than 5 ppm. Listed waste D011. |
| Lindane solution waste | Toxic | EP Toxic, lindane concentration greater than 0.4 ppm. Listed waste D013. |
| Spent halogenated solvents | Toxic | Listed waste F001, F002 (primarily 1,1,1-trichloroethane, tetrachloroethylene) |

TABLE C-1
(Continued)

WASTES, ASSOCIATED HAZARDS, AND BASIS FOR HAZARD DESIGNATION

| Hazardous Waste | Hazard | Basis for Hazard Designation |
|---|---|---|
| Spent non-halogenated solvents (primarily acetone residues) | Ignitable | Listed waste F003 |
| Spent non-halogenated solvents (primarily toluene) | Ignitable, Toxic | Listed waste F005 |
| Wastewater treatment sludges from electroplating operations | Toxic | Listed waste F006 |
| Plating bath solutions | Corrosive, Toxic | Listed waste F007 |
| Leaded tank bottoms from the petroleum refining industry | Toxic | Listed waste K052 |
| Scrubber sludges | Corrosive, Toxic | Listed waste F016 |
| Spent pickle liquor from steel finishing operations | Corrosive, Toxic | Listed waste K062 |
| Discarded acetone | Ignitable | Listed waste U002 |
| Discarded benzene | Ignitable, Toxic | Listed waste U019 |
| Discarded benzidine | Toxic | Listed waste U021 |
| Discarded chloroform | Toxic | Listed waste U044 |
| Discarded ethyl acetate | Ignitable | Listed waste U112 |
| Discarded formaldehyde | Toxic | Listed waste U122 |
| Discarded iodomethane | Toxic | Listed waste U138 |
| Discarded lead acetate | Toxic | Listed waste U144 |
| Discarded mercury | Toxic | Listed waste U151 |
| Discarded methanol | Ignitable | Listed waste U154 |
| Discarded methylene chloride | Toxic | Listed waste U080 |

This treatment procedure renders a waste to a material containing no free liquids by the reaction of a cement kiln dust, water and waste. This material is then disposed of in the secure landfill.

Hazardous wastes are stored at the PROTECO facility in the container storage facility in sealed containers which are compatible with the wastes. The drums holding hazardous wastes will be stored in separate sections within the container storage area due to general and specific incompatibilities of the wastes. This area is discussed in greater detail in Section D.

The proposed tank farm will contain eight tanks for storage and/or treatment of wastes before additional treatment and/or disposal. The capacity and waste types for each tank are shown in Drawing B511-D-P20.

## C-1b General Description of Hazardous Wastes Treated, Stored or Disposed of at the Facility

PROTECO treats, stores and disposes of a broad range of hazardous wastes including solids, slurries, sludges and liquids. The wastes stored at the facility can be generally grouped in the following categories as defined in 40 CFR Part 261:

Ignitable
Corrosive
Extraction Procedure (EP) Toxic
Toxic
Acutely Hazardous

Hazardous wastes that will be accepted for treatment, storage or disposal at the facility are summarized in Table C-2, and include the following:

- Ignitable Mixtures (D001) - classified as hazardous due to their flammable characteristic. Wastes in this group have a flash

TABLE C-2

HAZARDOUS WASTES ACCEPTED AT PROTECO

| EPA Hazardous Waste No | Waste Classification | Wastes Included |
|---|---|---|
| D001 | Ignitable Waste | Acetone, methanol, isopropyl alcohol various oils, paint wastes, liquid tars, lacquer chip and lacquer base. |
| D002 | Acidic Solutions | Acid cleaning solutions, ferric chloride solutions, sulfuric acid and hydrochloric acid. |
| D002 | Alkaline Solutions | Alkaline cleaning solutions, sodium hydroxide, wastes generated in the production of chlorox. |
| | EP Toxic Wastes | Wastes w/EP Toxic metals concentrations from hair and beauty pro- ducts, electroplating operations and electrical part products. |
| F001,F002 | Spent Halogenated Solvents | Methylene chloride, 1,1,1-trichloroethane, and still bottoms. |
| F003,F005 | Spent Non-Halogenated Solvents | Acetone, ethyl acetate, xylene and toluene. |
| F006 | Electroplating Wastewater Sludges | Sludge with concentrations of cadmium, hexavalent chromium or nickel. |
| D013 | Pesticide waste | Lindane concentration higher than 0.4 ppm in shampoo waste. |
| K052 | Leaded Tank Bottoms | Tank bottoms from petroleum refining. |
| K062 | Pickle Liquor | Spent pickle liquor from steel finishing operations containing hexavalent chromium or lead. |

TABLE C-2 (Continued)

HAZARDOUS WASTES ACCEPTED AT PROTECO

| EPA Hazardous Waste No | Waste Classification | Wastes Included |
|---|---|---|
| P105 | Commercial Chemical Products | Off-spec chemicals |
| U002, U112<br>U154, U239 | Commercial Chemical<br>Products | Ignitable off-spec chemicals products |
| U019, U220 | Commercial Chemical<br>Products | Ignitable and toxic off-spec chemical products. |

point less than 140°F (60°C). The solvents accepted in this group include acetone, methanol, ethanol and isopropyl alcohol. In addition various oils, paint wastes, liquid tars, lacquer chip and lacquer base that are also flammable are accepted at the facility.

- Acidic Solutions (D002) - classified as hazardous due to their corrosive characteristics. All wastes in this category have a pH less than or equal to 2. The typical liquids accepted in this group includes acid cleaning solutions, ferric chloride solution, sulfuric acid and hydrochloric acid.

- Alkaline (Caustic) Solutions (D002) - classified as hazardous due to their corrosive characteristics. All wastes in this category have a pH greater than or equal to 12.5. This group typically includes alkaline cleaning solutions, sodium hydroxide and other wastes generated in the production of Chlorox.

- EP Toxic Wastes - these are metal bearing wastes that are not listed in 40 CFR Part 261. These wastes are classified as hazardous due to EP Toxic concentrations of metals greater than or equal to the values listed in Table C-3. These wastes typically are generated from the production of hair and beauty products, electroplating operations and the manufacture of electrical products.

- Spent Halogenated Solvents (F001, F002) - listed as hazardous wastes due to their toxic characteristics. Examples of this waste that are accepted at the site include methylene chloride, 1,1,1-trichloroethane, tetrachloroethylene and the still bottoms generated from their use in manufacturing operations. These wastes are generated primarily from the cleaning operations associated with the production of pharmaceutical products and the manufacturing of electrical components.

TABLE C-3

MINIMUM CONCENTRATION OF METALS FOR WASTES
TO BE CLASSIFIED AS "EP TOXIC"

| EPA Number | Contaminant | Minimum Concentration (milligrams per liter) |
|---|---|---|
| D004 | Arsenic | 5.0 |
| D006 | Cadmium | 1.0 |
| D007 | Chromium | 5.0 |
| D008 | Lead | 5.0 |
| D009 | Mercury | 0.2 |
| D010 | Selenium | 1.0 |
| D011 | Silver | 5.0 |
| D013 | Lindane | 0.4 |

- Spent Non-Halogenated Solvents (F003, F005) - listed as hazardous wastes due to their ignitable and/or toxic characteristics. Examples of this waste accepted at the site include acetone, ethyl acetate, xylene, and toluene. These wastes are typically generated in Puerto Rico from the production of pharmaceutical products and diagnostic medical devices.

- Wastewater Sludges from Electroplating Operations (F006) - listed as hazardous due to their toxic properties. The hazardous constituents for which this waste is listed typically include cadmium, hexavalent chromium or nickel. These wastes are generated by various electroplating operations in Puerto Rico.

- Pesticide Waste (D013) - classified as hazardous due to an EP Toxic concentration of lindane greater than 0.4 ppm. This waste is generated in Puerto Rico from a shampoo manufacturing operating process.

- Leaded Tank Bottoms from the Petroleum Refining Industry (K052) - listed as a hazardous waste due to its toxicity and hazardous concentrations of lead. This waste is generated during the refining and storage of petroleum.

- Spent Pickle Liquor from Steel Finishing Operations (K062) - listed as a hazardous waste due to its corrosivity and toxicity. The hazardous constituents for which this waste is listed typically include hexavalent chromium and/or lead.

- Commercial Chemical Products (P105) - listed as hazardous due to the property of acute toxicity as defined in 40 CFR 261.33(e). These wastes are generated as hazardous wastes because they are off-specification products or are intended to be discarded by a manufacturer.

- Commercial Chemical Products (U002, U112, U154, U239) - listed as hazardous due to the property of ignitability. These products are considered hazardous wastes because they have been discarded by a manufacturer or because they are off-specification products.

- Commercial Chemical Products (U019, U220) - listed as hazardous due to the properties of ignitability and toxicity. These products are considered hazardous wastes because they have been discarded by a manufacturer or because they are off-specification products.

- Commercial Chemical Products (U040, U044, U080, U122, U138, U144, U151, U188, U201, U210, U226, U228) - listed as hazardous due to the property of toxicity. These products are considered hazardous wastes because they have been discarded by a manufacturer or because they are off-specification products.

- Others - The facility will also manage other wastes, which, due to generator selection are to be managed as hazardous wastes. Such wastes include:

  - Contaminated soils and sludges
  - CERCLA (Superfund) site clean-up wastes
  - Unlisted off-specification discarded commercial products
  - other non-hazardous wastes requiring special management procedures.

The six (6) major waste streams which will be processed at the Proteco site are waste lindane solution (D013), corrosive wastes (D002), ignitable wastes (D001), lead bearing wastes (D008) and spent halogenated wastes (F001, F002), and CERCLA (Superfund) site cleanup wastes.

## C-2 Initial Waste Characterization [40 CFR 270.14(b)(2)]

### C-2a Proposed Waste Characterization Program

C-2a(1) Waste Pre-Acceptance Sheet. Proteccion Tecnica Ecologica, Inc. accepts both hazardous and nonhazardous waste streams for storage, treatment and/or disposal from many waste generators (private and governmental) in the Commonwealth of Puerto Rico. Since it is necessary for PROTECO to characterize a hazardous waste to determine if it can be successfully treated, stored or disposed of, prior to the acceptance of any hazardous wastes, a prospective client company (i.e., any generator including small quantity generators) will be required to fully document the characteristics of each hazardous waste stream to be stored, treated and/or disposed of at the facility. This information is recorded by the prospective client on a PROTECO Waste Pre-acceptance Sheet (WPS) provided by PROTECO for this purpose. A copy of the WPS is shown in Figure C-1.

The WPS requires a generator to provide information on the process generating the waste, the physical properties of the waste and the chemical properties of the waste including chemical components and concentrations of heavy metals. In addition, PROTECO requires submittal of a copy of all laboratory analyses performed by the generator to determine the hazardous nature of the waste. PROTECO also requires submittal of material safety data sheets (MSDS) from the generator to augment the WPS whenever they are applicable and available.

All of the waste characterization sheets detailing physical and chemical properties of the hazardous wastes accepted by PROTECO are contained in a bound file at the laboratory office. These sheets are kept as part of the operating record as required by 40 CFR Part 264.74 and will be kept for the life of the facility.

After PROTECO finishes the construction and outfitting their own laboratory, by July 1986, PROTECO will begin to require all current generators to send PROTECO a representative sample of the waste described in the WPS. All new generators will be required to submit both an updated WPS and a representative sample.

When a representative sample or new WPS and representative sample are returned to PROTECO, the PROTECO laboratory chemist will review the sheet

FIGURE C-1

## A. GENERAL INFORMATION

GENERATOR NAME ______________________ TRANSPORTER ______________________

FACILITY ADDRESS ______________________ TRANSPORTER PHONE ______________________

______________________ GENERATOR USEPA ID ______________________

______________________ GENERATOR STATE ID ______________________

TECHNICAL CONTACT ______________________ TITLE ____________ PHONE ____________

NAME OF WASTE ______________________

PROCESS GENERATING WASTE ______________________

## B. PHYSICAL CHARACTERISTICS OF WASTE

| COLOR | ODOR | PHYSICAL STATE @ 70°F | | LAYERS | FREE LIQUIDS | |
|---|---|---|---|---|---|---|
| | __ NONE __ MILD | | | | | |
| | __ STRONG | __ SOLID | __ SEMI-SOLID | __ MULTILAYERED | __ | __ |
| | DESCRIBE ________ | __ LIQUID | __ POWDER | __ BI-LAYERED | __ YES | __ NO |
| | | | | __ SINGLE PHASED | VOLUME ________ | |

| PH | | | SPECIFIC GRAVITY | | FLASH POINT | | |
|---|---|---|---|---|---|---|---|
| __ .2 | __ 7.1-10.0 | __ N/A | __ .8 | __ 1.3-1.4 | __ 70°F | __ 200°F | __ CLOSED CUP |
| __ 2-4 | __ 10.1-12.5 | | __ .8-1.0 | __ 1.5-1.7 | __ 70°F-100°F | __ NO FLASH | __ OPEN CUP |
| __ 4.1-6.9 | __ 12.5 | | __ 1.1-1.2 | __ 1.7 | __ 101°F-130°F | __ EXACT ____ | |
| __ 7 | __ EXACT ____ | | __ EXACT ____ | | __ 140°F-200°F | | |

## C. CHEMICAL COMPOSITION (Totals must add to 100%)

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

______________________ ________ %

## D. METALS __ TOTAL (PPM) __ EPA EXTRACTION PROCEDURE (mg)

| | | | |
|---|---|---|---|
| ARSENIC | ________ | SELENIUM | ________ |
| BARIUM | ________ | SILVER | ________ |
| CADMIUM | ________ | COPPER | ________ |
| CHROMIUM | ________ | NICKEL | ________ |
| MERCURY | ________ | ZINC | ________ |
| LEAD | ________ | THALLIUM | ________ |
| CHROMIUM (Hexavalent) | ________ | ________ | ________ |

## E. OTHER COMPONENTS TOTAL (PPM)

| | | | |
|---|---|---|---|
| CYANIDES | ________ | PCB's | ________ |
| SULFIDES | ________ | PHENOLICS | ________ |

FIGURE C-1 (CONTINUED)

F. SHIPPING INFORMATION

OT HAZARDOUS MATERIAL YES NO

PROPER SHIPPING NAME

AZARD CLASS ID NO RQ

ETHOD OF SHIPMENT BULK LIQUID BULK SOLID

DRUM (TYPE/SIZE)

NTICIPATED VOLUME GALS CUBIC YARDS

OTHER

PER ONE TIME WEEK MONTH

QUARTER YEAR

G. HAZARDOUS CHARACTERISTICS

REACTIVITY NONE PYROPHORIC SHOCK SENSITIVE

EXPLOSIVE WATER REACTIVE OTHER

OTHER HAZARDOUS CHARACTERISTICS

NONE RADIOACTIVE ETIOLOGICAL

PESTICIDE MANUFACTURING WASTE OTHER

USEPA HAZARDOUS WASTE YES NO

USEPA HAZARDOUS CODES

STATE HAZARDOUS WASTE YES NO

STATE CODES

H. SPECIAL HANDLING INFORMATION

HEREBY CERTIFY THAT ALL INFORMATION SUBMITTED ON THIS AND ALL ATTACHED DOCUMENTS IS COMPLETE AND ACCURATE AND THAT ALL KNOWN OR SUSPECTED HAZARDS HAVE BEEN DISCLOSED.

AUTHORIZED SIGNATURE TITLE DATE

for content and completeness and the representative sample will be analyzed by PROTECO as described in the Waste Analysis Plan (Section C-3). If the WPS returned to PROTECO is incomplete, the PROTECO chemist will telephone to request additional information from the generator. This information will be added to the generator's WPS by the PROTECO chemist. PROTECO will decline to accept the waste if a generator refuses to provide PROTECO with a WPS and a representative sample of the waste.

When PROTECO has determined that the WPS is complete, a review will commence to determine if the waste can be handled by the facility in an environmentally safe manner. Based on the following, PROTECO will decide whether to initially accept the waste.

- PROTECO operating procedures and available capacities
- Waste streams presently treated, stored or disposed by PROTECO
- Waste characterization sheet
- Generator's laboratory analysis of the waste
- Material Safety Data Sheets
- PROTECO's analysis of the representative sample
- Ability of PROTECO's facilities to manage the waste.

In addition to keeping all waste characterization sheets, PROTECO will keep all laboratory reports detailing physical and chemical properties of the hazardous wastes accepted by PROTECO in a bound file at the site laboratory. These reports will be kept as part of the operating record as required by 40 CFR Part 264.74 and will be kept for the life of the facility.

C-2a(2) <u>Generator Audits</u>. As of August 1985, the PROTECO chemist, salesman or other authorized representative of the facility visited major generators to conduct a "generator audit". This audit was conducted in addition to requesting a WPS and a representative sample from the generator. The audit allowed PROTECO to obtain a copy of the generator's process flow sheets, review the generator's processes that produce hazardous waste, determine the generator's knowledge about these wastes and see the generator's storage area and the containers used to transport the waste.

A total of twelve facilities were audited as the initial phase of this program. From these audits, PROTECO has identified the following:

- Major constituents in the waste and their percent ranges
- Types of cross contamination that could occur
- Generator's procedures to avoid contamination
- Errors or inconsistencies that could occur during shipping
- Waste to container compatibility
- Estimated annual production of the waste
- All known waste characterization data and its sources

A copy of the Generator Audit Form used by PROTECO in conducting these audits is provided in Figure C-2. This form will be kept in the generator's file at the laboratory office for the life of the facility.

As each generator audit is conducted by PROTECO, it will be noted in the generator audit log. The log will be kept as part of the facility operating record. Once a year, the log will be reviewed by the management staff of PROTECO to determine if any generators should be re-audited. A copy of the generator audit log that will be used is provided in Figure C-3.

C-2a(3) Generator/PROTECO Agreements. Once PROTECO agrees to accept a waste, the generator must agree to inform PROTECO of any changes in the hazardous waste received by the facility due to changes in raw materials, generator's processes or operational changes. The generator and PROTECO will also determine the variability that will be allowed to occur in the generator's waste. Waste variability will be determined by means of the WPS, analysis by PROTECO of the representative sample and the generator audit. For example, a waste may contain 20-30 percent methanol, 70 percent isopropyl alcohol and up to 10 percent water. PROTECO will determine if these ranges are acceptable to the facility. Again, the generator must agree to notify PROTECO of any changes in the variability of the wastes.

FIGURE C-2

PROTECO

GENERATOR AUDIT FORM

GENERATOR ______________________________

GENERATOR EPA ID # ______________________________

LOCATION ______________________________
______________________________

TELEPHONE ______________________________

CONTACT PERSONS ______________________________
______________________________

SIC CODE FOR PRINCIPLE PRODUCTS (4 DIGIT NO.)

a. ______________ b. ______________ c. ______________

HAZARDOUS WASTE GENERATED AT THE FACILITY

| Waste Description | EPA ID # | Quantity Generated/Month |
|---|---|---|
| a. | | |
| b. | | |
| c. | | |
| d. | | |
| e. | | |
| f. | | |

FIGURE C-2 (CONTINUED)

## PART II WASTE DATA

NAME OF WASTE ______________________________

PROCESS PRODUCING WASTE ______________________________

______________________________

POTENTIAL AND TYPES OF CONTAMINATION ______________________________

______________________________

______________________________

STORAGE CONTAINER ______________________________

### PHYSICAL INFORMATION

LIQUID __________ SOLID __________ SLUDGE __________ SLURRY __________

SP. GRAVITY __________ pH __________ FLASH POINT __________

COLOR __________ ODOR __________ TEXTURE __________

### CHEMICAL INFORMATION

| COMPONENT | AVERAGE CONCENTRATION % | HEAVY METALS | AVERAGE CONCENTRATION PPM |
|---|---|---|---|
| a. | | | |
| b. | | | |
| c. | | | |
| d. | | | |
| e. | | | |

Sulfur __________ Chlorine __________

FIGURE C-3

SERVICIOS CARBAREON INCORPORATED

GENERATOR AUDIT LOG

| Date | Generator | Address | Contact | Telephone No. | SCI Auditor |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

## C-3 Waste Analysis Plan
## [40 CFR 270.14(b)(3) and 264.13(b)]

### C-3a General Waste Parameters and Rationale for their Selection

C-3a(1) Pre-Acceptance Waste Characterization. As discussed in Section C-2, generators will be required to provide PROTECO with an initial pre-acceptance waste characterization. This initial pre-cceptance waste characterization will consist of submitting a completed Waste Pre-acceptance Sheet (WPS), any copies of laboratory analyses conducted on the waste, any Material Safety Data Sheets where applicable and a representative sample of the waste. This will provide PROTECO with the following information:

- Process generating the waste
- Physical properties of the waste
- Chemical properties of the waste including chemical components and their percentages.
- Source of data provided.

PROTECO will analyze each representative sample provided by the generator. The waste parameters analyzed for will be dependent on the classification of the waste and the information provided by the generator on the accompanying WPS.

C-3a(2) Incoming Load Testing Parameters (Fingerprint Parameters). Each incoming load will be tested for standard fingerprint parameters prior to acceptance at PROTECO. These parameters are selected to prevent acceptance of reactive materials, and incorrect storage of incompatible wastes. These parameters also ensure that the incoming waste load conforms to the representative sample sent to PROTECO with the Waste Pre-acceptance Sheet. These fingerprint parameters are listed in Table C-4.

TABLE C-4

STANDARD INCOMING LOAD
TESTING PARAMETERS FOR ALL WASTES

(Fingerprint Parameters)

pH
Flashpoint

Viscosity and/or Specific Gravity

Free Liquid/Water Content

Cyanides

Sulfides

The parameters noted in Table C-4 have been selected on the following basis:

- pH -- This parameter will be tested in ignitable and aqueous wastes, solids and EP Toxic solutions and sludges. For aqueous wastes, this will determine the amount of neutralizing agent required for treatment and will help determine compatability with the landfill liner system. This will determine if the waste is amenable with stabilization/fixation treatment and to determine compatibility with the landfill liner system.

- Flashpoint -- The flash point will be measured to determine the waste's ignitability and, therefore, special waste handling practices. Some ignitable waste liquids, sludges and solids will be rendered non-ignitable by using stabilization/fixation. Others may be shipped off-site in bulk quantities for incineration. Also, a change in the flash point is indicative of changes in waste concentration ranges.

- Viscosity -- The viscosity will help determine the best method for handling, storing and treating the waste. Changes in viscosity may affect handling, storage and treatment operations; and may indicate change in a waste characteristics or waste concentration ranges.

- Specific Gravity -- The specific gravity is important in determining optimum waste solutions for stabilization/fixation. Specific gravity is also significant because a change in specific gravity is indicative of a change in waste characteristics or waste concentration ranges. Also, density tests can be used as a quick indicator of halogenated organics contamination (such as PCB's) in a waste solvent or oil mixture.

- Free Liquids/Water Content -- The test for free liquids will be used to determine if a waste needs stabilization/fixation prior to landfilling. This test also signifies a change in waste characteristics and waste concentration ratios.

- Cyanide -- This parameter will be used to determine the presence of cyanide in the waste stream. This will help to determine whether the waste should be accepted or rejected since the presence of cyanide can indicate a reactive waste, and reactive wastes are not accepted by the facility.

- Sulfide -- This parameter will be used to determine if sulfide is present in the waste. This will be useful in determining if an aqueous waste, sludge and slurry can be treated by the stabilization/fixation treatment process. It will also be used to determine if a waste will be accepted or rejected since the presence of sulfide can be indicative of a reactive waste, and reactive wastes are not accepted by the facility.

The results of the pre-acceptance analysis of the generator's representative sample will be coded on what will be known as the Standard Reference Form. A copy of the Standard Reference Form is provided in Figure C-4. One copy of the Standard Reference Form stating the results of the analysis performed by the PROTECO laboratory will be kept in the laboratory as the standard laboratory reference. The values that are obtained from the analysis of the incoming load sample will be compared to the values on the Generator's Standard Reference Form. If the values are significantly different, the generator will be contacted to clarify the differences that have been noted.

C-3a(3) Supplemental Analyses.

C-3a(3)a Waste Characterization Testing Parameters. PROTECO analyzes wastes of certain hazard classifications with additional tests. These additional characterizations are specific for each waste and may be adjusted by the PROTECO facility chemist based on information provided by the generator and analytical testing already completed.

The wastes which may be included in this testing program are listed in Table C-5. Discussion of the selection of these additional parameters are given in Table C-6 and Appendix C.1.

FIGURE C-4

PROTECO

STANDARD REFERENCE FORM

Sample No. ________

Generator Name: ______________________ Date: ________
Address: ______________________
City: ____________ State: ________ Zip Code: ______
Generator Contact: ____________ Telephone: ________

Waste to be Analyzed:
Process Producing Waste: ______________________
Date Sampled by the Generator: ______________________

Processed by: ______________________
Date Processed: ______________________

Physical Characteristics

Physical State: ____________ Color: ________
Odor: ____________ Texture: ________
Specific Gravity: ____________ Viscosity: ________

Chemical Characteristics

pH: ________ Flash Point: ________ Water Content: ________
Cyanide: ________ Sulfide: ________ Halides: ________
Oxidizable Organics: ________ Chlorides: ________

Other Applicable Information: ______________________
______________________________________________
______________________________________________
______________________________________________
______________________________

Transport Method ______________________

Container Type ______________________

Signature: ______________________

TABLE C-5

ADDITIONAL WASTE CLASSIFICATION TESTING

| Waste Classification | Test Method | Method Source |
|---|---|---|
| Halogenated Organics<br>F001<br>F002 | Gas Chromatography | EPA Method 8010 (Halogenated Volatile Organics) |
| Cadmium Contaminated Wastes<br>D006 | Digestion/AA | EPA Method, (Appendix C-8) |
| Chromium Contaminated Wastes<br>D007<br>F006, F007<br>K062, F016 | Digestion/A | EPA Method 218.1 (Total Chromium)<br>EPA Method 7196 (Hexavalent Chromium) |
| Lead Contaminated Wastes<br>D008, K049-K052 | Digestion/AA | EPA Method 239.1 |
| Mercury Contaminated Wastes<br>D009 | Digestion/AA | EPA Method (Appendix C-8) |
| Selenium Contaminated Wastes<br>D010 | Digestion/AA | EPA Method (Appendix C-8) |
| Lindane Solution<br>D013 | Gas Chromatography | EPA Method (Appendix C-8) |
| Toxic Organics<br>U044, U122, U138,<br>U220, U080, U188,<br>U201, U210, U239,<br>U225, U228, U021,<br>P105, F003, F005,<br>U002, U019, U112 | Gas Chromatography | EPA Method (Appendix C-8) |

TABLE C-6

RATIONALE FOR WASTE CHARACTERIZATION TESTING

| Waste | Test Parameter | Rationale |
|---|---|---|
| D001 | Flashpoints | Flash points of ignitable wastes are less than 140°F |
| | EP Toxic (Pb,Cr) | Paint wastes may contain Pb or Cr pigment |
| D002 | pH | Determines reactivity and treatment needed |
| | Buffer Capacity | Determines treatment |
| | Cloride | Determines treatment method. |
| | Cyanide | Amount of CN determines reactivity and disposal option |
| | Metals | Determines treatment |
| F001, F002 | Cyanide | Determines reactivity |
| | Flashpoint | Determines ignitability |
| | pH | Determines reactivity |
| F003, F005 | Flashpoint | Determines ignitability |
| F006 | pH | Determines reactivity |
| | Cd,Cr,Ni | Determines treatability |
| D013 | Sp. Gravity | Determines concentration of lindane in wastewater |
| K052 | Metals | Determines disposal options |
| | CN, Sulfide | Determines reactivity |
| K062 | Hexavalent Cr,Pb | Either of these two may be present |
| P105 | pH | Determines reactivity |
| | Flashpoint | Determines ignitability |
| | CN, Sulfides | Determines reactivity |

C-3a(3)b Process Specific Waste Testing Parameters. Some of the additional testing of wastes at PROTECO are the process specific analyses, shown in Table C-7. The results of these analyses provide the PROTECO chemist with another level of confidence concerning the proper means of treatment, storage and disposal. Some of these additional analyses utilize unique procedures and protocol formulated for PROTECO for proper waste characterization. Others are standard analytical techniques recognized by the USEPA and ASTM.

The rationale behind these process specific tests are given below:

- Oxidizable Organics -- This test will be used to determine easily oxidized organic substances such as aldehydes, alcohols or other simple poly-functional compounds in ignitable compounds and non-halogenated solvents. This will be useful in determining treatment of organic waste by using either stabilization/fixation or resource recovery at an off-site facility.

- Halogen Test -- The halogen test will be used to establish if a waste contains trace or larger quantities of halogens. This information will be useful in determining treatment of a waste by using stabilization/fixation treatment method. The test will be useful in determining changes in waste characteristics by contamination of the waste with halogenated solvents and the accuracy of the WPS. Compatibility of the waste to the landfill liner system can be determined from this data. This test can also be used to determine whether the material is acceptable for off-site incineration.

- Chloride -- This will be used to determine the presence of chlorides in the waste. The parameter will be characterized in aqueous wastes, slurries and sludges. These tests will be useful in determining if the waste can be treated by the stabilization/fixation treatment process, since chloride, though much less toxic than many other materials, is difficult to bind by this method.

TABLE C-7

PARAMETERS AND TEST METHODS

| Parameter | Test Method | Reference |
| --- | --- | --- |
| Arsenic | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Barium | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Cadmium | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Chromium | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Fluoride | Colorimetric or Potentiometric | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Lead | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Mercury | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Nitrate (as N) | Colorimetric Method 352.1 | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Selenium | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Silver | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Lindane | Gas Chromatograph | Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in water and Wastes |
| Chloride | Colorimetric | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| Iron | Atomic Absorption or Phenanthroline Method | Standard Methods for the Examination of Water and Wastewater, 14th Ed., American Public Health Association, 1975 |
| Manganese | Atomic Absorption | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |

TABLE C-7 (CONTINUED)

PARAMETERS AND TEST METHODS

| Parameter | Test Method | Reference |
|---|---|---|
| Phenols | Gas Chromatograph Method 8.04 | Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, USEPA SW-846. |
| Sodium | Flame Photometric Method | Standard Methods for the Examination of Water and Wastewater, 14th Ed., American Public Health Association, 1975 |
| Sulfates | Colorimetric | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983. |
| pH | Electrometric | Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, U.S. EPA SW-846. |
| Specific conductivity | Method 120.1 | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-790020, March 1983. |
| Total organic carbon | Combustion, Methods 415.1 | Methods for Chemical Analysis of Water and Wastes, EPA-600/4-790020, March 1983. |
| Total organic halogens | Method 450.1 | USEPA, Office of Research and Development, Environmental Monitoring and Support Laboratory, EPA-600/4-81-056, November 1980 |
| Coliforn Bacteria | Standard Plate Count | Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Association, 1975. |
| Paint Filter | Method 9095 | Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, U.S. EPA SW-846. |

- Percent Acidity -- determines the acidity in the waste by species. It is only used if the waste is aqueous and below a pH of 7.

- Percent Alkalinity -- determines the amount of alkalinity in the waste by species. It is only used if the waste is aqueous and above a pH of 7.

- Stabilization/Fixation -- is run to determine whether the waste is amenable to stabilization/fixation and to determine the ratio for each waste required to effect stabilization/fixation.

- Liquid Waste Compatibility -- is tested to determine whether liquid wastes stored or processed together are compatible.

- Paint Filter Test -- is used to indicate if free liquid is present in a solid or semi-solid material.

## C-3b Test Methods

Table C-7 lists the test methods that will be used by PROTECO to measure each of the analytical parameters described in Section C-3a. The table also lists a reference source for each test method. A copy of each of the test methods used by the site that are not a standard EPA test method as found in either "Test Methods for Evaluating Solid Waste" or "Methods for Chemical Analysis of Water and Wastes" are provided in Appendix C.2.

## C-3c Sampling Methods

Proper sampling is necessary to obtain reliable information for the management of hazardous wastes. Hazardous wastes arrive at the site in variety of containers, devices and quantities. The sampling methods used by PROTECO will ensure that a representative sample of waste is obtained.

C-3c(1) Obtaining Representative Samples from Generators. Each generator interested in having hazardous wastes treated, stored or disposed of at the PROTECO facility will be required to provide PROTECO with a representative sample of their waste. The generator will also be required to submit a PROTECO Generator Sample Form as provided by PROTECO along with the representative sample. The generator will be required to sign the certification at the bottom of the form. A copy of the Generator Sample Form that will be used and the instruction sheet are provided in Figure C-5. Additionally, the PROTECO chemist will review the sampling method to ensure that it is correct.

C-3c(2) Procedures for Collecting Representative Samples at PROTECO. Hazardous wastes will be delivered by outside transporters or by the PROTECO transportation staff to the facility for treatment, storage and/or disposal by any one of the following methods:

- Bulk Deliveries
  - Liquids
    - 10,000 gal. tanker truck
    - 8,000 gal. tanker truck
    - 3,000 gal. vacuum truck
  - Solids and Sludges
    - 8, 16, 22, 30 or 40 $yd^3$ dump trucks
- Containerized
  - Liquids
    - DOT approved containers that may vary in volume capacity from several milliliters to possibly 100-gallons. Most deliveries, however, will be contained by either 55-gallon metal or polyethylene drums.
  - Sludges
    - DOT approved containers that may vary in volume capacity from several milliliters to possibly 100-gallons.

FIGURE C-5

Sample No. ________________

GENERATOR SAMPLE FORM

Return this sheet completed and signed with a 1000-ml representative sample to the following address:

PROTECCION TECNICA ECOLOGICA INCORPORATED
Firm Delivery
Ponce, Puerto Rico 00731.

Name of Generator ________________________________________________

Address of Generator ______________________________________________
street P.O. Box

__________________________________________________________________
city state zip code

Name of Contact __________________________________________________

Telephone Number (____) __________________________________________

Generator's EPA I.D. Number _______________________________________

Collector ____________________ Date ____________ Time __________ Hours

Purpose of Sampling ______________________________________________

Type of Sample ___________________________________________________

Type of Process Producing Sample __________________________________

__________________________________________________________________

Field Information (including sampling equipment and sampling methodology used) ____________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

I believe that the information submitted herein is true, accurate and complete.

Signature ______________________________ Date ____________________
authorized personnel

PROTECO Approval of Sampling Mehtod

Chemist ________________________________ Date ____________________

(0566B)

FIGURE C-5 (CONTINUED)

PROTECCION TECNICA ECOLOGICA INCORPORATED

WASTE APPROVAL SHEET

---

1. Complete to the best of your knowledge an PROTECO Waste Characterization Sheet. Do not leave any spaces on the sheet blank. If a question is non-applicable, please put N/A in the blank.

2. Collect, package, and label for shipment and analysis one 1000-ml (approximately two pints) representative sample of each waste to be considered. Please be sure to attach a label to each sample container. The label should include the sample collector's name, the date and time the sample was collected, the generator's sample number, and the generator's name and address.

3. Include in the same package with each sample a completed and signed copy of the attached Generator Sample Form.

4. Return the original completed and signed waste Characterization Sheet along with the representative sample and the Generator Sample Form to the following address:

PROTECO<br>
Firm Delivery<br>
Ponce, Puerto Rico 00731.

Note: The sampling method you use must meet federal guidelines and your sample must be representative. Call us before sampling if you are unsure what to do.

Most deliveries, however, will be contained by either 55-gallon metal or polyethylene drums.

- Solids

  - Approved DOT cardboard and/or metal containers of varying capacities with most such deliveries contained in 55-gallon containers.

Only wastes in DOT approved transportation containers are accepted at the site. Representative samples will be collected by PROTECO upon receipt of the waste at the site. Certain procedures and equipment have been classified by EPA as suitable for obtaining representative samples of hazardous waste. Table C-8 lists the sampling equipment that will be used by PROTECO to sample various types of waste, based on the information provided by EPA. Appendix C.3 shows the sampling equipment used and describes proper sampling procedure.

Random sampling methodology will be used in collecting the representative samples from the containerized waste received in each waste shipment. Ten percent (10%) of the containers holding each specific waste type that are received in each shipment will be analyzed by PROTECO. All containers shall be grounded prior to the beginning of the sampling process if the receiving container is made out of metal. The random sampling procedures and the random number table that will be used by PROTECO are provided in Appendix C.4.

All hazardous wastes shipped by either vacuum truck or tanker will have representative samples collected when they reach the facility. Grab samples will be pulled through each accessible hatch using a weighted bottle sampler. A composite sample made from the combined grab samples will be analyzed. These grab samples will be taken from a range of depths to compensate for any separation of phases.

TABLE C-8

SAMPLING EQUIPMENT FOR VARIOUS TYPES OF WASTE

| Waste Type | Sampling Equipment | Additional Information |
|---|---|---|
| Ignitable or chlorinated wastes in drums, barrels and similar containers | COLIWASA (glass) | Not for containers greater than 5 ft. deep. |
| Corrosive wastes in drums, barrels, vacuum trucks and similar containers | COLIWASA (plastic) | Not for containers greater than 5 ft. deep. |
| Wastes transported by tanker trucks | Weighted bottle sampler | May be difficult to use on very viscous liquids. |
| Sludges in drums, barrels, dump trucks or similar containers | Trier | Waste should be moist or sticky. |
| Powdered or granular solids in bags, drums, barrels or similar containers | Thief | Sample particles should be 0.6 cm in diameter or less. |
| Large grained solids in bags, drums, barrels or similar containers | Large trier | May incur difficulty in retaining core of very dry granular materials. |
| Wastes received in containers of one (1) gallon or less. | Pipette | Not for containers larger than one gallon. May be difficult to use on viscous materials. |

Source of Information

"Samplers and Sampling Procedures for Hazardous Waste Streams," EPA 600/2-80-018.

Hazardous wastes received in dump trucks would be sampled as a sludge or a solid since free liquids are not transported by this method. Depending on the waste consistency, a sample would be collected using either a sample thief or trier. One sample would be withdrawn from at least three different points including the back, middle and front of the dump truck. Also, samples will be taken from a variety of depths if phasic wastes are present (the presence of phasic wastes is determined by slow insertion of a glass sampling rod, sealing of the top and bringing the rod into visibility). These samples will be combined to form a representative composite sample of the waste.

Most of the hazardous wastes that are received at the facility in containers of one gallon or less are known "commercial chemical products" as described under 40 CFR 261.33(f). They are received at the facility due to off-specification conditions or because the generator has discarded the "material". Such wastes are sampled using a pipette.

Table C-9 lists the recommended sampling points for the types of wastes received at the facility and Table C-10 describes the methodology that will be used by PROTECO sampling personnel to insure that a representative sample is collected.

Table C-11 describes the sample containers that will be used by PROTECO sampling personnel whenever representative samples are collected from the wastes received by the facility. All precautions will be taken to ensure that the sample containers are inert to the waste being collected. Since glass is inert to most hazardous waste, it will be used most often.

Before sampling any incoming hazardous waste, the PROTECO sampling personnel will typically wear the following personnel protective equipment:

- disposable, chemical-resistant coveralls
- chemical resistant gloves and boots
- safety glasses or goggles
- chemical-cartridge respirator

TABLE C-9

SAMPLING POINTS FOR WASTE CONTAINERS

| Container Type | Sampling Point |
|---|---|
| Drum, bung on one end | Withdraw sample through the bung opening. |
| Drum, bung on side | Lay drum on side with bung up. Withdraw sample through the bung opening. |
| Barrel, fiberdrum, buckets, sacks, bags | Withdraw samples through the top of barrels, fiberdrums, buckets and similar containers. Withdraw samples through fill openings of bags and sacks. Withdraw samples through the center of the containers and two different points diagonally opposite the point of entry. |
| Vacuum truck and similar containers | Withdraw sample through open hatch. Sample all other hatches. |
| Dump truck | Withdraw samples through at least three different points near the top of pile to 2 points diagonally opposite each other. |
| Tank trucks | Sample from the top through the sampling hatch. Withdraw sample from top, middle and bottom of tank. |

* Source of Information

"Samplers and Sampling Procedures for Hazardous Waste Streams", EPA-600/2-80-018.

TABLE C-10

METHODS USED TO SAMPLE HAZARDOUS WASTES

| Sampling Method | Description of Sampling |
| --- | --- |
| **Sampling a Drum** | |
| 1. Position drum so bung is up.<br>2. Allow contents of drum to settle.<br>3. Slowly loosen the bung with a bung wrench.<br>4. Allow gas pressure to be released.<br>5. Remove bung and collect sample with Coliwasa through bung hole. | Prepare a representative composite sample using the Coliwasa sampler by taking three (3) grab samples from bottom, middle and top of the drum. |
| **Sampling a Vacuum Truck** | |
| 1. Open the tank hatch.<br>2. Collect a sample with a Coliwasa.<br>3. When necessary, take a sediment sample through the drain spigot. | Prepare the representative composite sample collected from the liquid sample and the sediment sample taken from the vacuum truck. |
| **Sampling a Tanker or Storage Tank** | |
| 1. Open the tank hatch.<br>2. Collect a sample from the tanker with a weighted bottle sampler. | Prepare the representative composite sample using the weighted bottle sampler by taking three (3) grab samples from bottom, middle and top of the tanker. |
| **Sampling a Barrel, Fiberdrum, or Bags** | |
| 1. Position the container in an upright position.<br>2. Open the container slowly.<br>3. Collect a composite sample using either a sampling thief or trier depending on waste consistency. | Prepare a representative composite sample from three (3) grab samples from bottom, middle and top of container using either the thief or trier. |
| **Sampling a Dump Truck** | |
| 1. Determine waste consistency.<br>2. Determine the sampling points and angles (front, middle and back of truck).<br>3. Collect samples using sampling trier | Prepare a representative composite sample by withdrawing samples through the three different points near the top of the pile and to two points diagonally opposite each other. |

*Source of Information
"Samplers and Sampling Procedures for Hazardous Waste Streams", EPA-600/2-80-018

TABLE C-11

SAMPLE CONTAINERS USED FOR VARIOUS TYPES OF WASTE

| Waste Type | Example of waste | Sample Container |
|---|---|---|
| Oil waste | Hydraulic oil | 1 Qt. polyethylene |
| Halogenated organics | Methylene chloride | 1 Qt. glass or amber glass |
| Non-halogenated organics | Toluene | 1 Qt. glass |
| Phenolic wastes | Phenol | 1 Qt. glass |
| Photosensitive wastes | Tetrahydroforan | 1 Qt. amber glass |
| Metal bearing wastes | Electroplating sludges | 1 Qt. polyethylene |
| Acidic wastes | Sulfuric acid | 1 Qt. polyethelene |
| Alkaline wastes | Sodium hydroxide | 1 Qt. polyethylene |
| Pesticide wastes | Lindane solution | 1 Qt. glass |
| Ignitable wastes | Acetone | 1 Qt. glass |

After the grab samples have been taken and the composite sample prepared, the composite sample will be labeled and then logged into the PROTECO laboratory analysis log book.

C-3d Frequency of Analysis

As each generator's representative sample is received by PROTECO it will be analyzed for a number of parameters as described in Table C-4. Parameters that are analyzed will be selected by the facility chemist using Table C-4, the hazard classification of the waste and the information provided by the generator of the WPS as references. The result of these original analyses are noted in the Standard Reference Form (Figure C-4). In general, all parameters in Table C-4 will be run for incoming load fingerprint testing, unless the waste type indicates that the testing is not applicable (example: testing viscosity or pH of a solid).

All wastes received by PROTECO in a vacuum truck, tanker, or dump truck will be subject to incoming load fingerprint testing upon receipt. Ten percent (10%) of the containers of each specified waste type received in each waste shipment will be routinely fingerprint tested by PROTECO. Random sampling methodology will be used to choose the containers to be sampled. Any time PROTECO analyzes a waste that is received in a waste shipment, the laboratory will analyze those parameters chosen by the facility chemist based on historical and analytical knowledge of the waste. The results of this analysis will be recorded on the Incoming Load Sample Result Form (Figure C-6).

The results of the analysis of the waste shipment will be compared to the results of the original analysis performed on the generators representative sample as listed on the Standard Reference Form (Figure C-4). Table C-12 lists the frequency of analysis as described above.

FIGURE C-6

INCOMING LOAD
SAMPLE RESULT SHEET

Sample No. ________

Generator Name: ______________________________

Address: ______________________________

City: ______________ State: __________ Zip Code: _____

Sampler's Name: ______________________________

Location of Sampling: ______________________________

Date: ______________ Time: ______________

Waste to be Analyzed: ______________________________

EPA Code No.: ______________ Manifest No.: ______________

DOT Labels: ______________________________

Field Information (Sampling methodology, weather): ______________

______________________________________________________________

______________________________________________________________

Physical Characteristics

Physical State: ______________ Color: ______________

Odor: ______________ Texture: ______________

Specific Gravity: ______________ Viscosity: ______________

Chemical Characteristics

(See Standard Reference Form)

pH: __________ Flash Point: __________ Water Content: __________

Cyanide ______________________________ Halides: __________

Oxidizable Organics: ______________________________

Waste Accepted or Rejected: ______________________________

Signature of Laboratory: ______________________________

(0540B-13)

TABLE C-12

FREQUENCY OF ANALYSIS

| Type of Shipment | Frequency |
|---|---|
| Vacuum Truck | Every shipment received by the facility. |
| Tanker Truck | Every shipment received by the facility. |
| Dump Truck | Every shipment received by the facility. |
| Flatbed with drums, barrels or similar containers | 10% of the containers for each specific waste received in each shipment. |
| Semitruck with drums, barrels or similar containers | 10% of the containers for each specific waste received in each shipment. |
| Representative Sample sent by a generator | All samples received by the facility. |

### C-3e Procedures for Recharacterizing Wastes

As required in 40 CFR 264.13 (a)(3) an analysis must be repeated as necessary to ensure that it is accurate and up to date. A generator is to inform the facility of any changes in his/her waste due to process or operational changes or any changes in raw materials. In addition to this agreement, PROTECO will send a notification letter annually to any generator whose hazardous wastes are accepted for treatment, storage or disposal. This form will be completed, signed by the generator and returned to PROTECO. The form will be kept at the site laboratory for the operating life of the facility and will be filed in the generator's folder. A copy of the notification letter is provided in Figure C-7.

If changes are noted in the letter, PROTECO will request a new WPS and representative sample from the generator. The new representative sample will be analyzed by the PROTECO laboratory following the pre-acceptance testing methodology. The procedures described in Section C-2b(1), Initial Waste Characterization, will be utilized to determine if the "new" waste will be accepted.

## C-4 Screening and Evaluation of Waste Shipments [40 CFR 270.14(b)(3) and 264.13(c)]

### C-4a Procedures for Characterizing Waste Shipments

PROTECO's objectives in characterizing each waste shipment received at the facility will be to document consistency between the waste and the manifest and to assure that the waste received from a generator is the waste the facility expected to receive. Although PROTECO requires all generators to notify PROTECO of changes in a waste, PROTECO will implement a variety of screening tests, as described in the waste analysis plan in Section C-3, on a routine basis to assure fulfillment of these objectives.

FIGURE C-7

GENERATOR NOTIFICATION LETTER

(DATE)

Generator Name
Generator Address

Dear (Contact Name)

Attached you will find a Generator Notification Form. PROTECO requests that all generators whose hazardous waste is treated, stored or disposed of at the PROTECO facility complete and return the attached form to the Penuelas office within 30 days of the receipt of this letter. The form should be filed out by persons knowledgeable of plant processes, operational procedures and the wastes generated from each process.

In order for PROTECO to continue handling the treatment, storage or disposal of your hazardous wastes it is necessary for you to return a completed form to the office. If the form is not received or you have not contacted the PROTECO office within 30 days of receipt of this letter, PROTECO will no longer be able to treat, store or dispose of your hazardous wastes.

If you have any questions, please feel free to call the Lab Manager at (809) 836-2058. We are looking forwarded to hearing from you.

Very truly yours,

Jorge Fernandez
President

FIGURE C-7 (CONTINUED)

PROTECCION TECNICA ECOLOGICA, INC.
FIRM DELIVERY
PONCE, PUERTO RICO 00731

## Generator Notification Form

Generator EPA ID No.: ____________________

Generator Name: ____________________

Generator Address: ____________________

____________________

____________________

Generator Contact: ____________________

*******************************************************************************

1. Have any changes occured during the last year or do you expect any changes to occur in the future that have affected or could affect the plant processes?
   Yes ________ (Go to 2)
   No ________ (Go to 3)

2. Please describe these changes and how they could or have affected the wastes generated by your facility.
   ____________________
   ____________________
   ____________________
   ____________________

3. Have "new" raw materials or chemical products been substituted or added to an existing plant processes?
   Yes ________ (Go to 4)
   No ________ (To to 5)

4. Please list all the new materials that have been substituted or added to an existing plant process.
   ____________________
   ____________________
   ____________________

5. Has or does the facility plan to add or develop a new plant process to manufacture products?
   Yes ________ (Go to 6)
   No ________ (Go to 7)

6. Please describe the new plant process and the waste that may be or are being generated from the operation of this plant process.
   ____________________
   ____________________
   ____________________

FIGURE C-7 (CONTINUED)

PROTECCION TECNICA ECOLOGICA
FIRM DELIVERY
PONCE, PUERTO RICO 00731

Generator Notification Form (Continued)

7. Have operational procedures been altered that could result or have re sulted in an increase or decrease in the chemical components (i.e. composition) in the waste itself?

   Yes ________ (Go to 8)
   No ________ (Go to 9)

8. Please describe the changes that af fected the chemical composition of the waste and describe the new chemi cal composition of the waste, listing chemical components and their per centages

   ____________________
   ____________________
   ____________________
   ____________________
   ____________________
   ____________________

9. Have any new operational procedures been established or are expected to be established that could result in the generation of a new waste stream or a change in the chemical composition of the old waste stream?

   Yes ________ (Go to 10)
   No ________ (Go to 11)

10. Please describe the new operational procedure and the wastes that might be generated from this operation including information on chemical components and their percentages.

    ____________________
    ____________________
    ____________________
    ____________________
    ____________________

11. Please describe any other changes that have occurred in the last year that have affected the types or quantity or waste being generated at the facility includ ing changes in waste component ranges.

    ____________________
    ____________________
    ____________________
    ____________________
    ____________________

12. Does your facility expect an increase or decrease in the waste generated in the coming year?

    Increase ________
    Decrease ________

I believe that the information submitted herein is true, accurate and complete.

________________________ ________________________
(Signature) (Date

(0566B)

## C-4b Waste Shipment Screening Procedures

Each shipment received at PROTECO is subject to a standard procedure for waste acceptance. These procedures are outlined in Figure C-8.

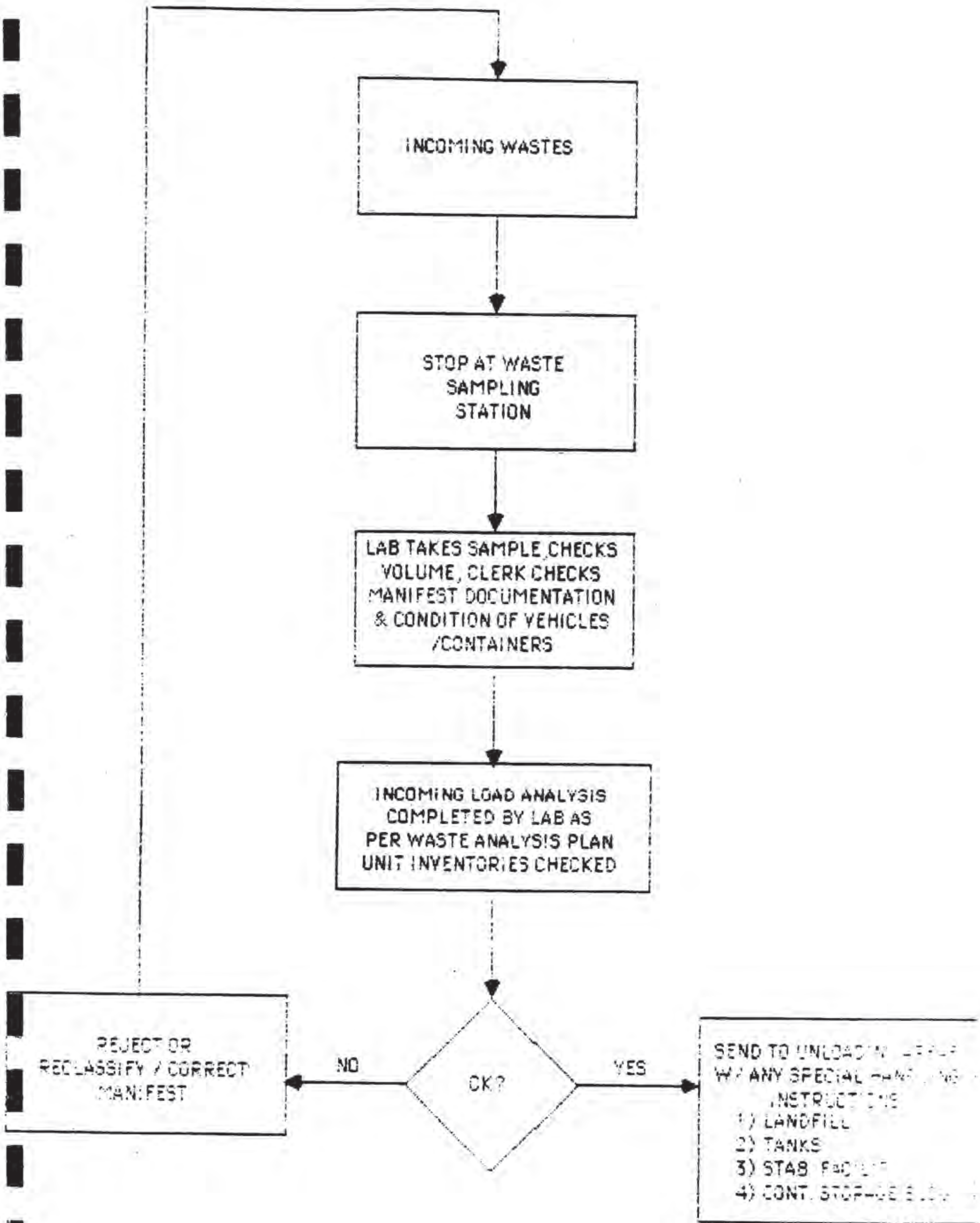
PROTECO's first objective is to note any manifest discrepancies. A manifest discrepancy is a difference between the quantity, including differences in weight of a shipment or in a number count of containers, or the type of hazardous waste designated on the manifest and the quantity or type of hazardous waste a generator receives. The detection of manifest discrepancies will be noted by visual inspection, weighing or unit count and chemical analyses performed by the PROTECO laboratory. PROTECO will count all discrete units (i.e., containers) in the shipment or record the volume of entire shipment depending on the type of containment used and the waste description on the manifest. The number of containers or the volume of the shipment will then be checked against the manifest.

As described in the preamble to the Federal Regulations on hazardous waste, the detection of manifest discrepancies in type is intended to "have facilities flag obvious differences in waste type... as opposed to more subtle changes, such as parts-per-million variations in the concentrations of heavy metals within a sludge". Differences in type are, therefore, noted by PROTECO using visual inspection and rapid incoming load fingerprint analyses as previously described that are performed during and after the collection of a representative sample. Ten percent of containers for each specific waste type received in a shipment, accessible ports on a tank truck or vacuum truck, and all dump trucks containing bulk sludges or solids are visual inspected and analyzed for the following items at a minimum:

- Physical state of the waste
- Color
- Flashpoint
- Odor
- Texture
- Specific Gravity or Viscosity

**FIGURE C-8**

INCOMING WASTE PROCEDURES



- Free Liquids/Water Content
- Cyanides
- Sulfides

The representative composite samples are collected and labeled as described in Section C-3c and a laboratory number is given to the sample. A copy of the results obtained from the analyses performed will be kept in the laboratory on a Sample Result Form (Figure C-5).

C-4c Procedures for Screening Restricted Wastes

PROTECO does not accept reactive wastes for treatment, storage or disposal at the facility. Therefore, PROTECO will analyze those wastes that have potential for reactivity due to fact that they may be cyanide or sulfur bearing wastes which, when exposed to pH conditions between 2 and 12.5 can generate toxic fumes, gases or vapors. In general, all waste shipments will be screened for cyanide and sulfide unless the test is clearly not applicable.

C-4d Procedures for Accepting or Rejecting Waste Shipments

PROTECO rejects waste shipments for the following reasons:

- the weight of the waste shipment or the number of containers in a waste shipment is found to be inconsistent with the manifest information

- the waste shipment is a restricted waste or includes waste units that contain a restricted waste (i.e., a reactive waste) due to unacceptable levels of cyanide or sulfide

- the analyses performed indicate significant off-specification conditions (i.e., change in viscosity, specific gravity, pH, free liquids)

The waste shipment will be initially recorded by volume or the containers counted. PROTECO will allow a discrepancy limit of ten percent in weight of the manifested volume for bulk shipments. If there is a discrepancy of one container in the waste shipment, PROTECO will contact the generator and try to resolve this discrepancy. If the discrepancy in volume or number of containers cannot be resolved between PROTECO and the generator, the shipment will be rejected and returned to the generator.

Next, PROTECO will visually inspect the waste for physical state, color, odor and texture. If discrepancies in the waste seem apparent based on visual inspection, PROTECO will postpone a discussion to reject the shipment until after the waste is screened for specific gravity, viscosity and other fingerprint parameters. If the tested parameters are within specified tolerances for the waste, the waste will be accepted; otherwise the shipment will be rejected by the facility and the generator will be contacted to resolve the problem.

Once a generator is contacted for resolution of such a problem, PROTECO will advise the generator that the waste has been rejected for one of the following reasons:

- a discrepancy in the volume
- a discrepancy in the number of containers as listed on the manifest
- analysis of the representative samples collected by PROTECO is not consistent with historical information.

PROTECO will resample and reanalyze the waste only if discussions with the generator present strong evidence that the waste has not changed and that errors in shipment are unlikely. If further testing does not resolve the discrepancy, the waste must be rejected and recharacterized as a new waste. The decision to reject a waste is made by the Lab Manager.

## C-5 Waste Analysis Plan for Containers [40 CFR 264.172, 264.175 and 264.177]

### C-5a Procedures for Assuring Compatibility of the Waste with Container Materials

To prevent premature deterioration of a container it is necessary for the wastes stored at the facility to be compatible with the container and the container liner material. All hazardous wastes accepted by PROTECO for treatment, storage or disposal at the facility are originated by a generator at his/her location. At the time of initial waste stream approval, PROTECO will recommend to the generator the container and/or liner that would be compatible with the waste based on the information provided in Table C-13. PROTECO will also record the container type on the Standard Reference Form.

PROTECO visually inspects all containers in a waste shipment when they are received and accepted at the facility checking for obvious signs of deterioration or leakage. In addition, PROTECO accepts only those containers for transport to the facility that are DOT-approved containers. As described in Section F, PROTECO also visually inspects all containers stored in the drum storage area on a weekly basis, again checking for signs of container deterioration, leakage or pressurization.

### C-5b Container Storage Facility Waste Movement Procedures

Standard procedures have been developed for receiving wastes at the container storage facility (Figure C-9). After incoming waste acceptance procedures at the PROTECO gate, the truck is directed to the container storage building.

The operator of the facility reinspects the waste shipment, verifies the manifest and issues an initial waste movement form (WMF). This waste movement form details all the information obtained on the entire shipment. The containers are then moved into the waste receipt section of the facility and grouped according to waste class.

TABLE C-13

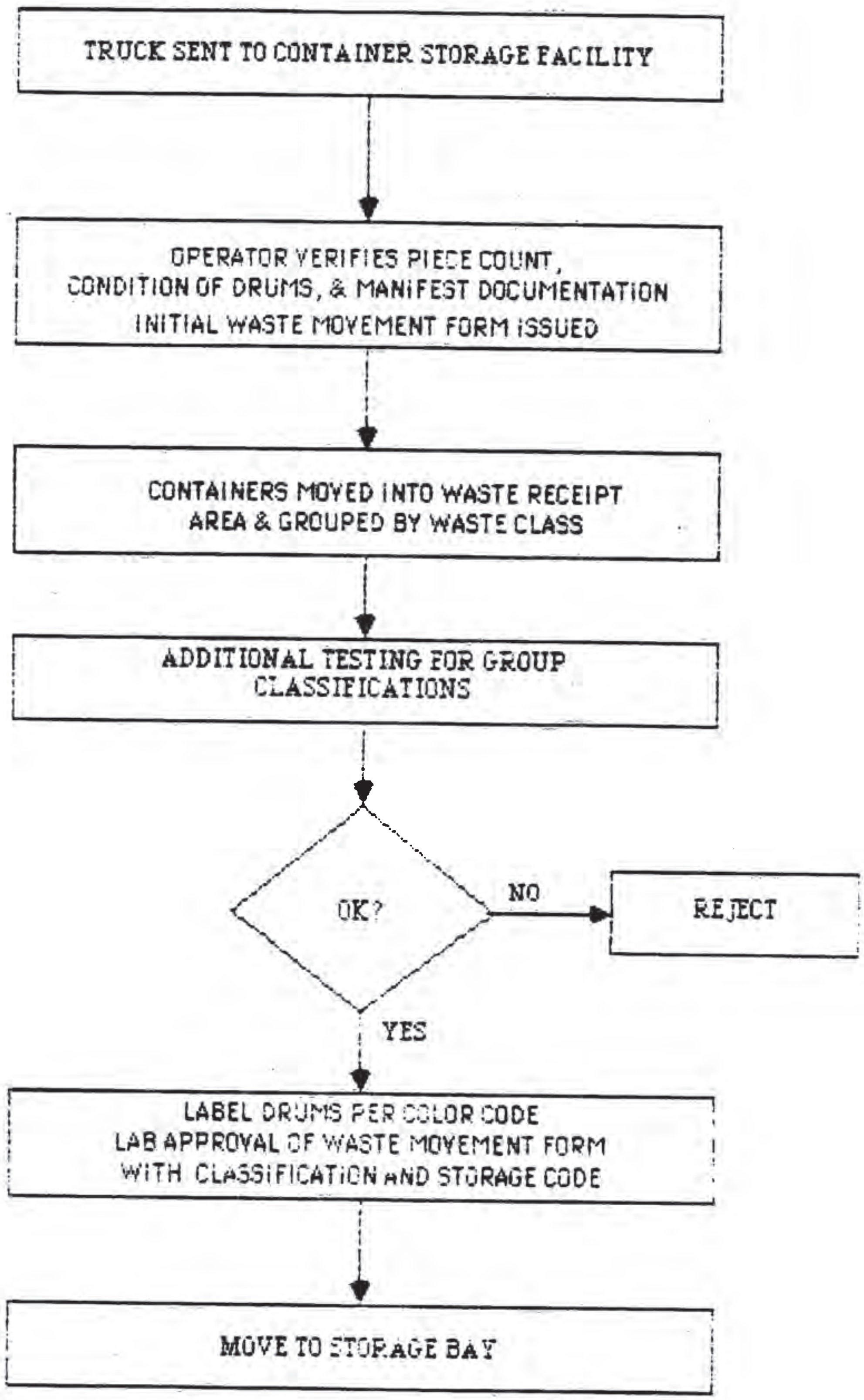
COMPATIBILITY CHART: CHEMICALS VERSUS CONSTRUCTION AND LINING MATERIALS

| Construction Material | Chemicals Incompatible With |
| --- | --- |
| Steel | Mineral Acids: nitric, hydrochloric, sulfuric acids |
| Aluminum | Alkalies: potassium hydroxide, sodium hydroxide, mineral acids |
| Magnesium | Mineral acids |
| Lead | Acetic acid, nitric acid |
| Copper | Nitric acid, ammonia |
| Nickel | Nitric acid, ammonia |
| Zinc | Hydrochloric acid, nitric acid |
| Tin | Organic acids, alkalies |
| Titanium | Sulfuric acid, hydrochloric acid |

| Lining Materials | Chemicals Incompatible With |
| --- | --- |
| Alkyds | Strong mineral acids, strong alkalies, alcohols, ketones, esters, aromatic hydrocarbons |
| Vinyls (polyvinyl-chloride-PVC) | Ketones, esters, aromatic hydrocarbons |
| Chlorinated Rubbers | Organic solvents |
| Epoxy: (amine-cured, polyamide cured, or esters) | Oxidizing acids (nitric acid), ketones |
| Coal Tar Epoxy | Strong organic solvents |
| Latex | Oxidizing acids, ketones, esters |
| Polyesters | Oxidizing acids, strong alkalies, mineral acids, ketones, aromatic hydrocarbons |
| Silicones | Strong mineral acids, strong alkalies, alcohols, ketones, aromatic hydrocarbons |

**FIGURE C-9**

CONTAINER STORAGE FACILITY



At this point, the trained operator will determine, after examination of all the previously acquired information on the wasteload, whether further testing of individual containers is necessary. The operator can require all of a shipment or only certain wastes or containers to undergo further testing such as a fingerprint analysis. Any containers which show manifest inaccuracies from this second level of testing will be rejected and held while the generator and PROTECO negotiate proper handling of the waste.

After this second level of testing is complete, the PROTECO laboratory issues a waste movement form and a color coded label which state the waste classification. Each container is affixed with a label and moved to the storage bay for wastes of that classifications. A copy of the waste movement form is kept at the container storage facility while the original is stored at the PROTECO Laboratory.

### C-5c Procedures for Characterizing Collected Leaks, Spills and Runoff

PROTECO is not expected to generally experience any significant leaks or spills in the container storage area. If a leak or spill should occur, the procedures delineated in Section G, the PROTECO Contingency Plan, would be followed. In general, liquid spills would be managed as per the same waste classification as the spill producing the waste.

The proposed container storage facility will have a series of separate bays with individual sumps to collect spills and leaks. Typically the contents of the sumps will be assumed to contain a hazardous waste and the contents will be treated by one of the facilities hazardous waste treatment or storage processes.

Refer to Section D for further discussion of spill collection

### C-5d Procedures for Assuring Compatibility of Wastes with Used Containers

Empty used containers will not be reused at the facility. In limited circumstances, solids of the same waste class may be combined as part of

Container Storage Facility operations. Refer to Section D-1 for further discussion of this aspect. Used containers will either be crushed and disposed of as hazardous waste or returned to the original generator for reuse in storing the same waste stream.

## C-6 Waste Analysis Plan for Stabilization/Fixation Facility [40CFR 270.14(b)(2)]

Two types of wastes will be accepted for stabilization/fixation at the PROTECO facility, liquids and solids/sludges. The handling of these wastes is outlined in Figure C-10 and Section D-9.

## C-7 Waste Analysis Plan for Landfills

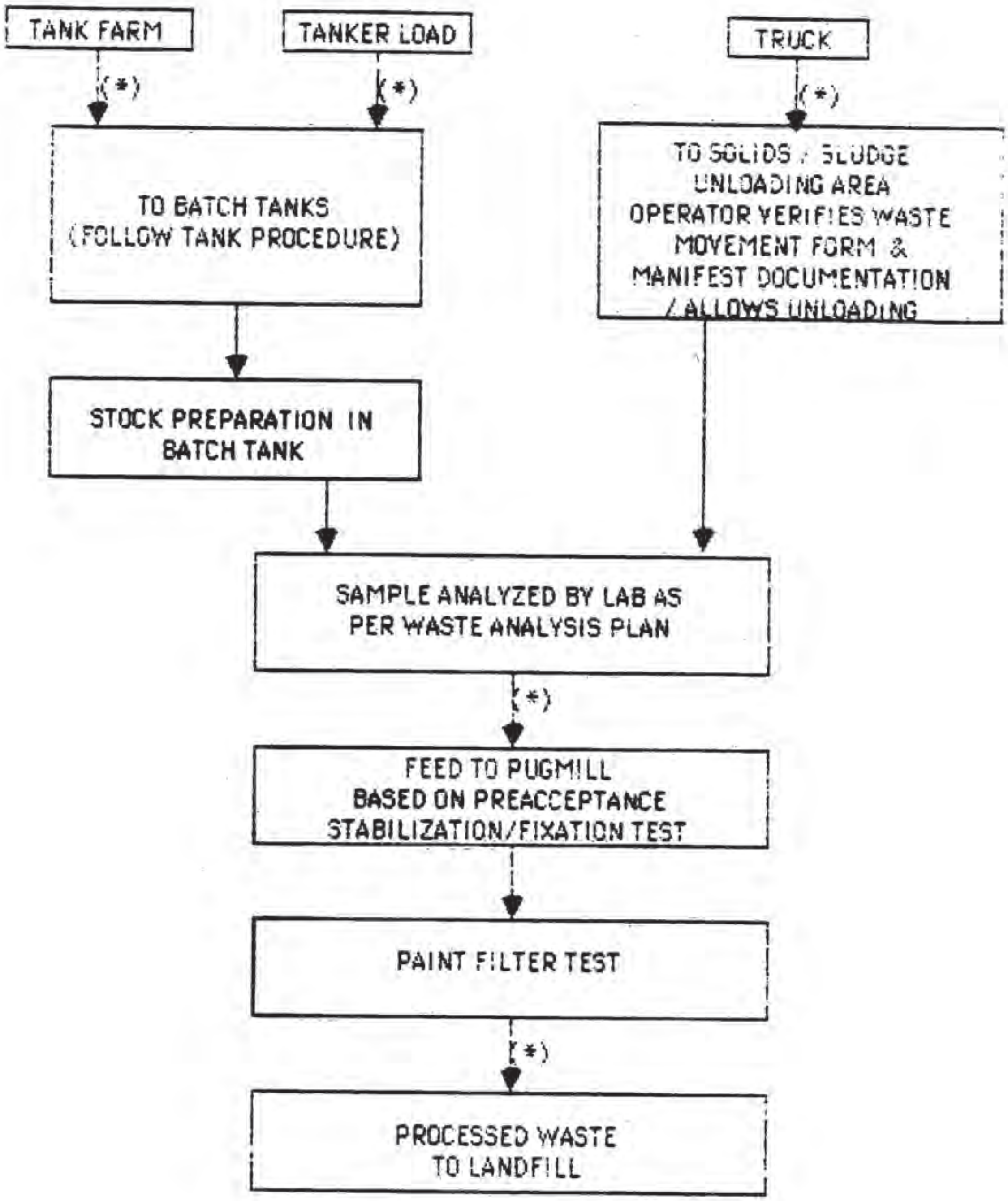
As stated previously, all wastes received at any of the PROTECO units must be accompanied by a waste movement form which has been completed and recorded at the PROTECO laboratory. This form accompanies all loads which are received at the landfill including on-site waste movements from the stabilization/fixation facility and solid wastes from the container storage facility. In this manner PROTECO ensures that no free liquids are disposed into the landfill. An outline of the waste movement procedures followed at PROTECO is shown in Figure C-11.

## C-8 Waste Analysis Plan for Tanks

Waste acceptance procedures has been developed for the PROTECO tank farm to prevent mixing of any incompatible wastes or overfilling of any tank. These procedures, outlined in Figure C-12, involve a double check from the laboratory to verify the tank contents and capacity. Each waste classification has a separate color code. The key to the locking cap for the tank containing the waste has the same color code. After the operator checks the manifest and waste movement form he obtains the correct color key from the PROTECO laboratory, which verifies the remaining capacity in the tank.

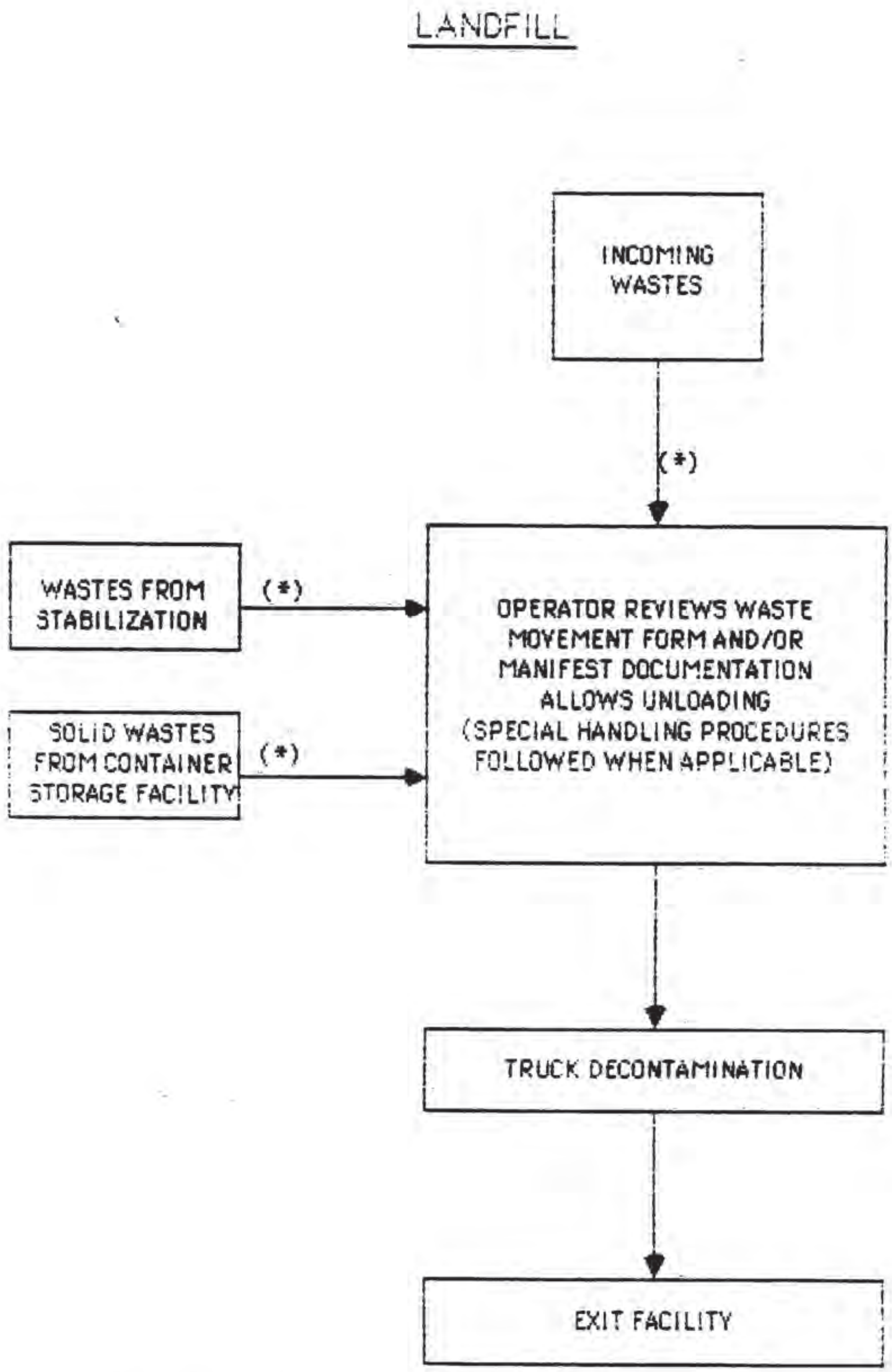
# FIGURE C-10

## STABILIZATION/FIXATION FACILITY




(*) = WASTE MOVEMENT FORM ISSUED

**FIGURE C-11**




(*) = WASTE MOVEMENT FORM ISSUED

**FIGURE C-12**



TANKS

TRUCK SENT TO UNLOADING AREA

↓ (*)

OPERATOR AT TANK FARM:
1) VERIFIES WASTE DESCRIPTION VERBALLY
2) CHECKS MANIFEST
3) RECONCILES DESCRIPTION ON WASTE MOVEMENT FORM VS MANIFEST
4) VERIFIES REMAINING TANK CAPACITY

↓

IF OK, LAB ISSUES COLOR CODED TAG
FOR LOCKING CAP TO OPERATOR

↓

OPERATOR CONFIRMS COLOR CODE ISSUED BY LAB
WITH WASTE MOVEMENT FORM

↓

TRUCK UNLOADED

↓

OPERATOR RETURNS KEY & DOCUMENTATION TO LAB
WITH FINAL LEVEL READINGS

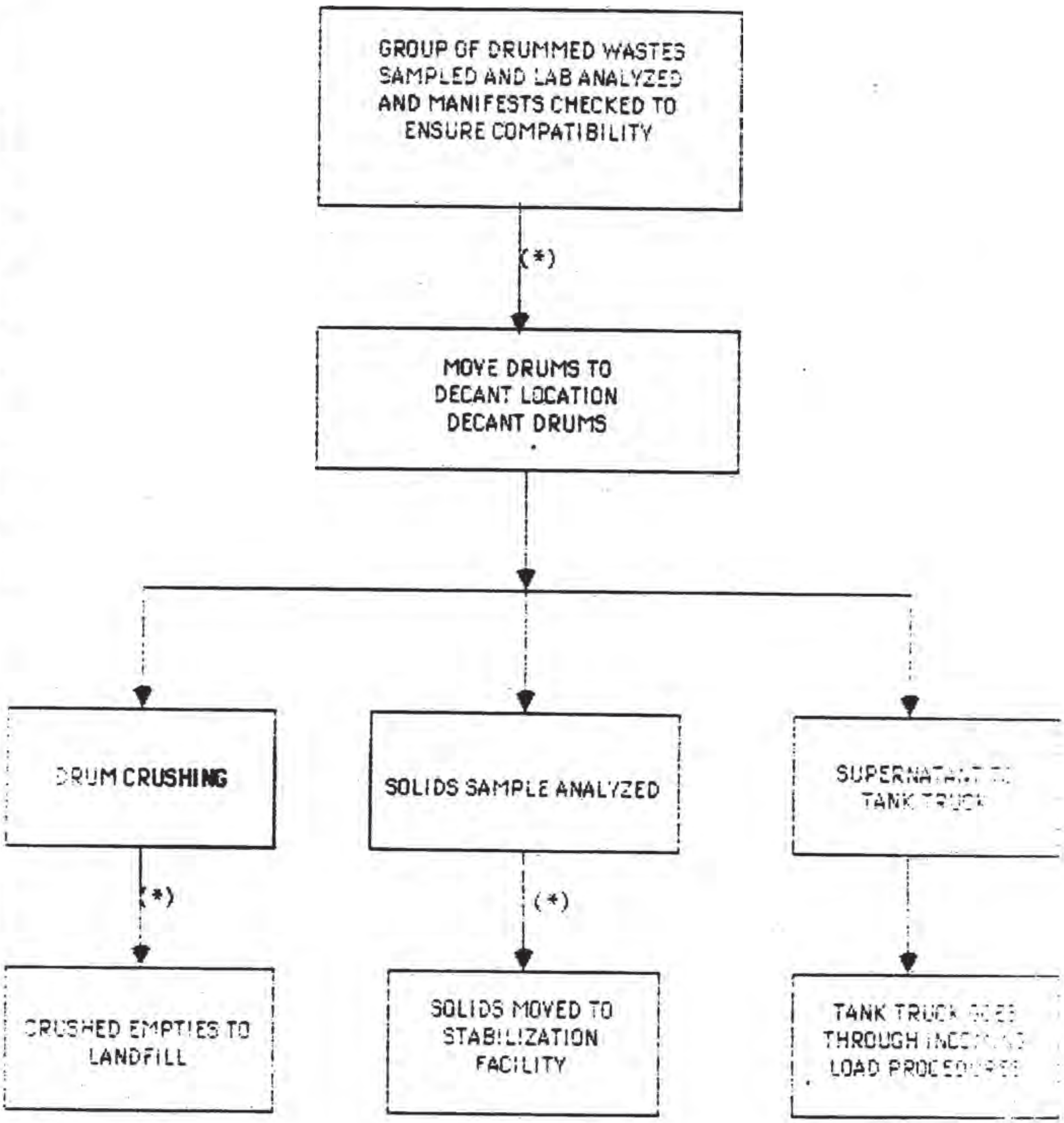
↓

TRUCK DECONTAMINATION

(*) =WASTE MOVEMENT FORM ISSUED

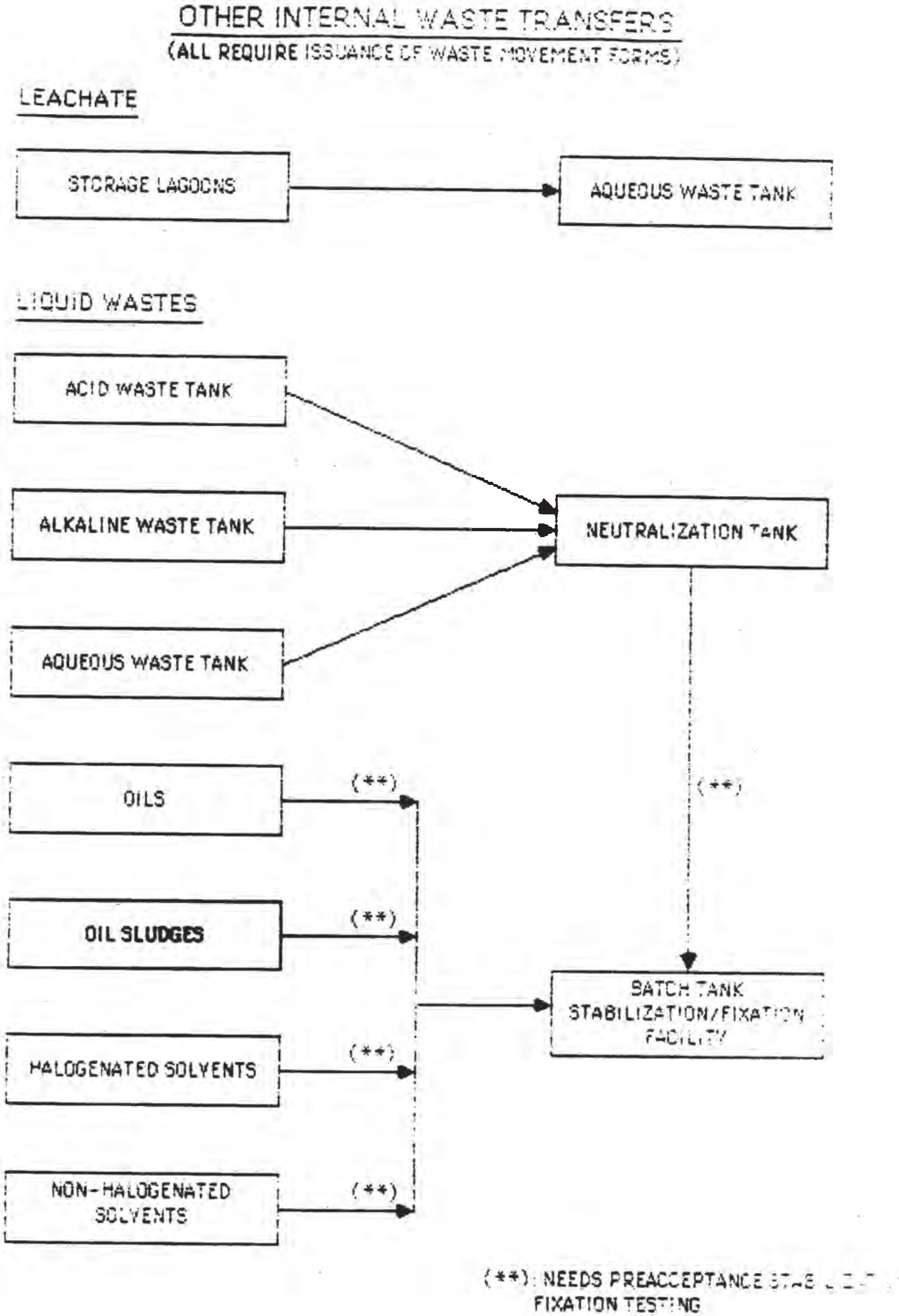
# FIGURE C-13

## DRUM DECANT OPERATIONS




(*) = WASTE MOVEMENT FORM ISSUED

FIGURE C-14


OTHER INTERNAL WASTE TRANSFERS
(ALL REQUIRE ISSUANCE OF WASTE MOVEMENT FORMS)
LEACHATE
STORAGE LAGOONS
AQUEOUS WASTE TANK
LIQUID WASTES
ACID WASTE TANK
ALKALINE WASTE TANK
AQUEOUS WASTE TANK
NEUTRALIZATION TANK
OILS
OIL SLUDGES
HALOGENATED SOLVENTS
NON-HALOGENATED SOLVENTS
(**)
BATCH TANK
STABILIZATION/FIXATION
FACILITY
(**): NEEDS PREACCEPTANCE STABILIZATION/
FIXATION TESTING

## C-9 Testing Programs for Liners

A liner testing program is continuing at the PROTECO facility. Liner materials have been selected to meet the "Minimum Technology Standards" for liners as published by the Environmental Protection Agency. Table C-14 summarizes the status of PROTECO's liner testing program.

### C-9a General Liner Performance Standards

Liners systems which have been selected for the landfills and surface impoundments are:

- compatible and durable in the presence of waste fluids (leachate) to be contained
- have low permeability over extended periods of time
- reliable and have a low risk of failure and relative ease of installation quality control, repair and maintenance.

The following design elements address the above considerations:

- all lining, cap and piping outside liners will be high density polyethylene (HDPE), the lining material most resistant to the widest group of chemical characteristics impacting liner integrity.
- a three-liner system will be used, consisting of two layers of HDPE, above a three foot thick recompacted clay liner.
- all seams end HDPE pipe connections will be heat welded, to provide as monolithic a system as possible.
- a comprehensive quality control program for soil components (clay) and the liner material (HDPE) will be followed during landfill and surface impoundments construction (refer to Quality Control Plans and Project Specifications for further information).

TABLE C-14

SUMMARY OF LINER COMPATIBILITY TESTING

1) Previous synthetic liner compatibility testing using waste samples from existing wastes conducted - Data shows HDPE superior to chlorinated polyethylene (CPE)

2) HDPE has been selected as the liner material and for piping outside of lined areas, based on overall compatibility property superiority.

3) PROTECO will submit to EPA:

--vendor-supplied compatibility data for HDPE and PVC (PVC is used in the leachate collection piping)

--permeability/compatibility testing for:
--clay materials

--sands/gravels/crushed stones to be used in the leachate collection systems

--filter cloths to be used in the leachate collection systems.

In general, wastes will only be accepted for direct land disposal which are known to be compatible with the liner, based on previous compatibility test data. Any new candidate wastes where compatibility data or known waste properties do not clearly indicate compatibility will either be:

- subject to additional testing for liner compatibility, or

- treated in the stabilization/fixation process to change the waste characteristics to those suitable for land disposal.

C-9b <u>Testing of On-site Soil to Determine its Use as a Liner</u>

On-site material, suitable for use as a liner and meeting impermeability standards (less then 1.0 x $10^{-7}$ cm/sec) will be used as the third liner (below the two synthetic liners). Previous testing of this material clearly indicates its suitability for use as an impermeable lining material. Since it is the third liner, this material will have no direct contact with the wastes themselves.

Section D-6, Landfills, discusses the strength of the soil liner and provides testing results and calculations showing the suitability of this soil as a liner. Actual construction of the liner material will be conducted following rigid quality control practices, which will include compaction and permeability testing. Refer to the Quality Control Documents and Project Specifications for further information.

A summary of the Liner Compatibility Testing is given in Table C-14.

## C-10 Testing Program for Closure of the Facility [40 CRR 264.178 264.197 and 264.228]

### C-10a Procedures for Assuring Decontamination of Containers

Hazardous wastes are removed from their containers by either pumping or pouring. All wastes that can be removed by using one of these two methods are removed till there is less than 2.5 centimeters (one inch) of residue remaining on the bottom of the container or inner liner. These containers are no longer considered a hazardous waste and are therefore not subject to regulation under 40 CFR 261 through 265, however, they will still be carefully managed. These containers will either be returned to the original generator or crushed and buried on-site as a hazardous waste.

### C-10b Procedures for Assuring Decontamination of the Proposed Storage Facility at Closure

At closure, each of the container storage area bays will be decontaminated using a series of solvent washes followed by clean water rinses. The wastewater generated from this decontamination procedure will be collected in each of the respective containment system sumps. Samples representative of the rinsings in each storage bay will be collected from the sumps using Coliwasas. Wastewaters will be managed as hazardous waste in remaining on-site facilities.

# SECTION 3 - PROCESS DESCRIPTION

SECTION D-1

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## D-1 Containers

This section describes the facility and operations utilized to store and process hazardous wastes received at the PROTECO facility in containers.

PROTECO proposes to constrict one building within its facility for the storage and processing of containerized hazardous wastes. The Container Storage Building, shown on plans previously submitted to the Agency, is used for storage of a maximum of 1,536 55-gallon containers. Aqueous and liquid fuels consolidation and container decant are also performed at this location. In addition, a container crushing operation is proposed for the Building. A plan of the Container Storage Building is shown in Drawing B511-C-BL1.

### D-1a Description of Containers

In accordance with Federal regulations, and to minimize the likelihood of a container leaking while in storage, all wastes received by the facility will be packaged in US Department of Transportation (DOT)-approved shipping containers. Should waste be received in a non-approved container, or if the container holding the waste is not structurally acceptable, or if the container shows apparent structural defects, or if it begins to leak, the waste and/or container will be transferred into an acceptable container or returned to the generator. All drums will be closed prior to receipt at the facility and all containers will be closed at all times while maintained in storage except during waste transfer or sampling. Closed head drums will have bungs in place and the bungs will be tightly secured. Open-Top drums will have covers, gaskets, and rings, and the covers will be tightly secured. Leaking or badly damaged or rusted containers and closed-head drums with heads cut out will not be legally accepted for storage.

Common DOT container types used to contain wastes are provided in Table D-1-1. However, this listing is not intended to be an exclusive list

TABLE D-1-1

DESCRIPTION OF CONTAINERS

| | DOT Type | Description | Use |
|---|---|---|---|
| 1. | 5, Steel | 49 CFR 178.80 | Liquid and Solid Hazardous Waste |
| 2. | 5B, Steel | 49 CFR 178.82 | Same as above. |
| 3. | 17C, Steel | 49 CFR 178.115 | Same as above. |
| 4. | 6D, Steel | 49 CFR 178.102 | Non-Liquid Hazardous Waste |
| 5. | 17E, Steel | 49 CFR 178.116 | Same as above. |
| 6. | Fibre | Various sizes and shapes | Non-Flammable Solids |
| 7. | Salvage Drums, Steel | 49 CFR 173.3 80-gallon size | Overpack of damaged drums |
| 8. | Plastic Drum | As described in 49 CFR 173 | Non-Flammable and Flammable Solids; Flammable Liquids in closed Head Only; ORM-E Materials. |
| 9. | Other DOT Approved Containers. Ex-samples Include wooden containers, burlap, plastic and paper bags. | As described in 49 CFR 178 | Non-Reactive Non-Flammable Non-corrosive |

NOTE: Except for Lab Packs, wastes will not be accepted in glass containers. Lab-packed wastes will be segregated by the same waste classes as all other wastes; the requirement to separate will be passed on to the generators.

of containers that the facility uses. Selection of container type by the facility will be based upon DOT requirements.

D-1b Description of Container Storage Area

In order to provide environmentally safe and efficient container storage operations, PROTECO proposes construction of a new Container Storage Facility. This facility will be a separate building, with all facilities necessary for the safe storage and handling of hazardous waste containers. Design of the building is complete, and regulatory review of the plans has been completed. Design of the building is shown on the following plans:

| | |
|---|---|
| B511-C-G1 | Title Sheet |
| B511-C-SL3-SL5 | Site Layout |
| B511-C-BL1-BL3 | Facility Layout & Details |
| B511-C-P1-P2 | Piping Schematics, Layouts, Sections & Details |
| B511-C-SB1-SB7 | Structural Building Plans & Details |
| B511-C-E1, E2, E5, E7 & E8 | Electrical Layout & Details |
| B511-C-FP1-FP2 | Fire Protection System Plans |

Refer to Appendix for a copy of these plans.

Specifications covering this facility are entitled:

"Technical Specifications, Container Storage Building and Site Work for PROTECO", 8-18-85 (refer to Appendix D-1.1).

The building will be equipped with its own loading dock and curbed apron (providing containment). There will be 16 separate bays, each with their own containments, for storage of containers. Bay #18 and Bay #20 are reserved for container decant and container crushing operations. (Note - Plans and specifications for these operations will be submitted to the Agency by March 31, 1986).

Natural ventilation is provided in the building, along with a wet fire sprinkler system and eyewash/emergency shower systems specially designed for the warm climate. Because warm water could aggravate a burn condition, water will be continuously circulated from a below-ground tank to assure that water in eyewash/emergency shower systems remains cool. Finally, there is an emergency exit at the opposite end of the building from the loading dock area. The facilities are described in more detail as follows. Container Storage Facility Operations are shown schematically in Figure D-1-1.

D-1b(1) Dock Facilities. The building is designed to process approximately 160 drums per day. Because each truckload contains approximately up to eighty 55-gallon drums, the facility can handle approximately 2 truckloads per day. These incoming trucks, after incoming load testing at the laboratory, are directed to the Container Storage Facility Unloading Dock where the containers are unloaded and placed in the container receipt and staging area (see Drawing B511-C-BL1).

D-1b(2) Ventilation. The Container Storage Facility is naturally vented by being open (there are no side walls). For container Decant and Crushing Operations, a combustible gas meter will be installed to sample the atmospheres in Bays 18 and 20. Should the vapor exceed a preset fraction of the Lower Explosive Limit, an alarm will sound and portable explosion-proof fans will be used to clear vapors from the area.

D-1b(3) Fire Protection. The building has wet fire sprinklers that have been designed to meet NFPA 30 Class 1A flammable liquids criteria.

In the event of an activation of the sprinkler head(s), the fire water is impounded within the building containment system and analyzed, as described in Section C, prior to discharge to determine how it is to be disposed.

Even number bays are equipped with fire stops, and are suitable for ignitable waste storage. The fire stops will serve to prevent spread of flame from the building while safely discharging sprinkler water overflow

FIGURE D-1

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to the outside of the building from each bay. (Odd number bays have standard overflows, but no fire stops). The overflows and fire stops have been provided so that extended sprinkler system operation will not result in the spread of fire between bays due to drainage backups, nor result in the mixing of incompatible wastes nor drainage water.

Finally, drainage trenches are also provided at each end of the facility to prevent the spread of fire from the building, as required in NFPA codes. Similar trenches have been designed at the upper end of each pedestal (where the pedestal meets the transport aisle).

Electrical systems will be classified as explosion-proof in the Container Storage Facility.

D-1b(4) Waste Segregation. The proposed Container Storage Facility has been designed to provide satisfactory segregation of incompatible wastes. Sixteen separate bays are provided for this purpose, half of which are suitable for ignitibles storage. Classes of wastes will be the same as in the tank farm, with inert solids being handled with aqueous wastes. Containers will be placed and stored only in the bays, on raised pedestals. The pedestals pre-determine the correct locations where the containers can be placed, from an aisle and capacity standpoint.

## D-1c Secondary Containment System Design and Operation

The proposed Container Storage Facility area includes provisions for containing leaks and spills within the individual bays. This section describes the containment methods and procedures.

D-1c(1) Design Details and Capacity Calculations. The different bays of the storage facility will be delineated by walls and curbs. The walls and curbs will be as shown in the plans. Curb and wall sections will be keyed and the surface will be sealed with a durable and compatible material to ensure a complete seal at all joints. Drawing B511-C-BL1 summarizes the secondary containment capacity for all bays.

D-1c(2) Removal of Liquids from Secondary Containment. Because the storage bays have separate drainage systems, different strategies are required for removing liquids from each. However, the concept is similar in all cases. The objective is to remove liquids collected in the sumps before they overflow and create a potential hazard. The floor drainage pattern and sumps have been designed to easily accomplish this purpose.

Under normal conditions, the sumps should not contain liquids. However, if the floors are washed, the washwater will collect in the trenches. When this occurs, the liquid will be pumped from the sumps into a container or into the vacuum truck, and managed as the same waste class as the bay is designated. Analysis of the sump contents will also be conducted as necessary to determine compatibility of the collected liquid with other wastes in the tank from storage/treatment systems (refer to Waste Analysis Plan, Section C-3, for further information).

D-1c(3) Control of Run-off and Run-on. Because all operations will take place within the confines of the curbed and roofed building, no run-off or run-on waters will be generated.

## D-1d Container Management Practices

D-1d(1) Procedures for Receiving Containers. The PROTECO Container Storage Facility will be used to store hazardous wastes, with the following exceptions:

- Shock - Sensitive Waste
- Radioactive Wastes
- Highly Reactive Wastes
- Explosives
- Pressurized Gases in Cylinders
- TSCA - Regulated Wastes
- Pyrophoric Waste

All wastes received in containers at the facility are subject to the procedures outlined in Section C, Waste Analysis Plan.

D-1d(1)(a) Inbound Vehicles and Load Verification. All inbound vehicles with containers proceed from the laboratory to the unloading area for unloading and a second quality control check. An initial incoming load check at the laboratory is conducted such that samples are taken by the lab and analyzed, documentation is checked, inventories reconciled and the condition of containers and vehicles checked. The second quality control check at the Container Storage Facility includes operator verification of the container piece count, condition of drums and manifest documentation prior to unloading. Additionally, further testing is conducted for each group of containers to verify the waste class for proper storage (see Figure D-1).

After the piece count, the condition of drums and manifest documentation is verified, then unloading begins using forklifts equipped with forks or drum handling attachments. Containers are moved into the Waste Receipt Area and grouped by waste class. At this point, additional testing is conducted to confirm the proper waste storage classification.

When laboratory testing confirms the classification, the operator will mark each drum as follows:

| | |
|---|---|
| Yellow/Black | Acids |
| Yellow/White | Caustics |
| Yellow/Green | Aqueous Wastes and Inert Solids |
| Orange | Halogenated Solvents |
| Orange/Black | Non-Halogenated Solvents |
| Orange/Aluminum | Oils* |
| Orange/Green | Oil Sludges* |

*May be stored in the same bay

A Waste Movement Form will be used to document movement of container groups between the lab and Container Storage Facility Waste Receipt Area and from the Waste Receipt Area into the Storage Bays. After marking, the containers will be moved to the bays, with the Waste Movement Form returned to the lab for bay by bay inventory control.

"Off-Specification" indicates that the waste does not fall within the previous waste identification parameters. Such material may or may not be acceptable for handling at PROTECO. Off-Specification material is so indicated by marking an "X" as the container. If the reason for the off-specification is not remedied immediately, all covers and bungs are placed back on the drums. Off-Specification loads are handled as per the off specification procedures (see below).

D-1d(1)(b) Off-Specification Wastes. A load verification check is performed on each waste shipment received at PROTECO. If a shipment is off-specification according to the waste identification record, the Laboratory Manager files an off-specification report. The off-specification report is forwarded to the Operations Manager.

An off-specification shipment may or may not be acceptable at the facility. If the waste shipment is not acceptable at PROTECO, the generator is notified immediately and arranges for waste transportation to another approved facility or back to the generator. The off-specification report for acceptable waste types includes operations and laboratory steps necessary to handle the waste for facility records. Wastes received off specification may be the basis for re-evaluation of waste characteristics (see Waste Analysis Plan, Section C-3).

D-1d(2) Procedures for Storing Containers. All containers are stored in accordance with NFPA 30 for protected liquid warehouses. Containers are sealed prior to storage and drums are stacked a maximum of three tiers high. Between every other row of drums, a 5 foot aisle space is maintained to allow daily inspection of the containers for leakage. Class 1A flammables are stored in a similar manner, except drums are not stacked (one tier only).

Drums are stored within the bays with their own spill containment trenches, as previously described. Storage arrangements which block doors, utility stations, exhaust fans or safety stations are not allowed.

Wastes are stored in a compatibility arrangement based upon ultimate disposal or treatment. Drummed solids will be stored according to the wastes classes previously described. Designation of storage bays at this time is not possible since inventories vary considerably. Inclement weather conditions can also affect disposal and/or treatment activities, necessitating flexible waste storage patterns. Each bay, however, will be clearly marked with a panel above the center of the bay, marked with the color code and with the name of the waste class in Spanish and English.

D-1d(3) <u>Empty Container Treatment</u>. One of the more important operations of this facility's consolidation activities is the treatment and disposal of empty containers. Containerized wastes are received at PROTECO in three types of containers: glass vials and bottles (in lab packs only), plastic pails and drums, and metal pails and drums.

Polyethylene and other plastic containers are traditionally singletrip containers, and, therefore, in accordance with DOT regulations, are prohibited from re-use. Non-reusable plastic containers will be emptied of all contents and cut open. Those containers are then deposited in the secure landfill.

Metal drums, likewise, are not always DOT-approved for multiple shipments. Containers which are suitable for reuse may be returned to the generator for reuse if they are clearly suitable for reuse in storing the same original waste. All single-trip containers and those not acceptable for reuse, are crushed on-site in the drum crusher and disposed as a solid hazardous waste in the secure landfill.

PROTECO will maintain a drum crusher in Bay No. 20 of the Container Storage Building. This installation includes a sump containment system. Crushing operations will be located within a contained and sheltered area. Figure D-1-1 is a flow chart illustrating the operating procedures employed for processing empty waste containers.

D-1d(4) Procedures for Handling Containers. The disposition of empty drums is assigned by Lab and Operations personnel. Each drum is assigned a code which specifies the drum disposition handling precautions, and special handling requirements.

D-1d(5) Procedures for Waste Consolidation.

D-1d(5)(a) Liquid Waste Decanting. All liquid wastes in containers, which will be decanted for on-site storage or treatment or off-site burning or incineration are received, verified, and stored in the Container Storage Facility. Liquid wastes may consist of acid, caustic, organic constituents in water (non-characteristic aqueous wastes). Procedures for liquid waste decanting are provided in Section D-3.

D-1d(5)(b) Solids Consolidation. If the decanting of several drums containing similar, compatible materials results in numerous drums with more than one inch of solids remaining, the drums will be conveyed to the proposed drum decant area. There, the residues in the drums will be consolidated into a smaller number of drums and, if there is a remaining void space in the container, inert filler material will be added to occupy the remaining head space. This process reduces the number of full drums requiring land disposal.

Empty drums produced by this process will be sent to the drum crusher. Full drums will be moved to the appropriate storage bay designated by waste class until they are transported to the landfill for disposal.

D-1d(6) Drum Crushing. In conjunction with the proposed construction of the Container Storage Facility, a drum crusher will be installed in Bay No. 20.

Drums not suitable for reuse, i.e., drums that are not structurally acceptable, or drums that are specified by DOT regulations as being single-trip containers, are crushed and disposed in the secure landfill as hazardous wastes. If they contain one inch or less of residues, these drums may be sent to the drum crushing area from the decant operations, drum processing area, or from off-site.

The drum crusher is pneumatically operated and controlled, and is rated for use in a Class I, Division 1 area. The proposed drum crushing facility will be located within Bay No. 20, which has a concrete spill collection and containment area. This area will be inside the container storage building and adequate ventilation and fire protection is provided for in the design of the building. The concrete spill collection and containment area will be used to contain any leaks from the crusher. Leakage or drainage collecting in this sump will be removed via a pump and processed within the facility, by processing in the tank storage/treatment system, as aqueous waste.

D-1d(7) <u>Procedures for Separating Incompatible Wastes</u>. Generic group classifications used by PROTECO to prevent undesirable co-mingling of containerized and laboratory generated hazardous wastes were previously presented along and the color codes used to identify containers are the same as those presented in the Tank Section D-2e. Consolidation of wastes in the same container is limited to materials within a compatibility group. Additional information concerning the procedures or identifying groups of wastes and the methods for selecting process or storage area to which they are sent are contained in Section C, Waste Analysis Plan, and Section F, Procedures to Prevent Hazards.

D-1d(8) <u>Procedures for Handling Ignitable Wastes</u>. Fire protection for the drum crusher is provided by a sprinkler system that is activated automatically. Heat sensors located in the crusher unit will also be provided to sound an alarm if a high temperature condition occurs. Fire extinguishers are also located nearby (See Figure D-1-2. Detailed procedures and precautions for handling ignitable wastes are found in Section F, Procedures to Prevent Hazards.

FIGURE D-1-2

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Each of the storage areas where flammable liquids are stored are at least 50 feet from the facility property line in compliance with 40 CFR 264.176.

D-1e Requirement for the Base or Liner to Contain Liquids

The Container Storage Facility has been designed with an epoxy coating, consisting of a two-coat system. The prime coat will be a flexible coal tar modified epoxy with the finish coat being a heavy duty, high build thermosetting liquid tile coating. Two part epoxy coatings are typically resistant to the widest range of chemicals of any coating material available. Water-stops and joint compound are also called for in the design to assure overall integrity of the concrete base.

Storage surfaces are sloped at 1% to promote drainage, and each bay's containment area will hold in excess of 10% of the maximum volume of waste stored, without inundating the containers (which will be on pedestals). Run-on is not a concern, as the storage facility is a roofed building with 3 foot sidewalls. Additionally, the building sits above grade.

Refer to the plans and specifications for the Container Storage Facility for detailed information concerning all of the above (see Appendices A and D-1.1.

APPENDIX D-1.1

CONTAINER STORAGE BUILDING

TECHNICAL SPECIFICATIONS

This material was previously submitted, on January 31, 1986; PROTECO Master Documents List Plans and Specifications.

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SECTION D-2 <u>TANK FARM AND TREATMENT FACILITY</u>



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SECTION D-2 TANK FARM AND TREATMENT FACILITY

# D-2 Tank Storage and Treatment Facility

## D-2a General

The PROTECO site will include a facility for bulk storage and treatment of liquid wastes; called the Tank Storage and Treatment Facility. The proposed tank farm has been designed to allow for storage and treatment of liquid hazardous wastes in a secure, controlled manner in accordance with the applicable design and regulatory codes. The Tank Storage and Treatment Facility design is presented in the technical specification document and in the drawing package, Appendices D-4.2 and Appendix A, and are referred to herein. Appendix D-2.1 comprises the supporting tank calculations.

## D-2b Facility Description

The Tank Storage and Treatment Facility is located northwest of and in the vicinity of the entrance gate, within the same area allotted for the Stabilization/Fixation Facility and the Container Storage Facility. The facility consists of two (2) truck unloading areas on either side of the tank farm and a dedicated stormwater retention impoundment. The entire facility occupies an area approximately 200 feet by 150 feet.

The Tank Storage and Treatment Facility receives liquid wastes from tanker trucks or from the Leachate Ponds described in Section D-4. Waste liquids stored and treated in the Tank Storage and Treatment Facility are either directed to the Stabilization/Fixation Facility for ultimate disposal in the landfill or transferred off-site to another approved hazardous waste management facility.

The truck unloading areas are constructed of reinforced concrete slabs with curbing and catch basins for run-on/run-off control and spill containment during loading and unloading operations. The truck unloading areas are located directly on the truck access roads with ramping to maintain curbing containment at the truck entrance and exits. Roofing over the areas reduces precipitation run-on into the catch basins which drain by gravity drain to the stormwater retention basin. The stormwater retention impoundment has been designated a hazardous waste surface impoundment and is discussed in Section D-4.

The tank farm is a reinforced concrete structure containing eight (8) aboveground tanks with concrete sidewalls for secondary containment. Separate secondary containment is provided for each tank. A sump is located in each tank containment area to provide a low point for collection of rainwater. These tanks provide for segregated storage of liquid wastes, with the exception of the neutralization tank which serves for pH conditioning. The overall tank storage capacity of 160,000 gallons was developed based on historical waste receipt volumes and unloading and internal transfer criteria; e.g., large capacity tanker truck holds 10,000 gallons. The tanks are all atmospheric, with the two solvents tanks blanketed with nitrogen to a few inches water pressure for safe storage of ignitible wastes.

Dedicated piping and pumps are provided for each tank and waste class to assure waste compatibility and prevent cross-contamination. Unloading and internal transfer pumps are located local to each tank or unloading station and are separately contained for spill control with the use of drip pans and hoods.

A catwalk running down the center of the tank farm, over the containment walls, provides for access to the equipment. The catwalk also serves as a structure for the facility pipe runs, as indicated on the piping Drawings B511-D-P20 through P26. The piping to the Stabilization/Fixation Facility runs on grade and through a culvert under the roads as depicted on Drawing B511-D-P30.

Administrative and equipment controls are provided to assure waste segregation and compatibility and to protect against overfilling.

Personnel safety is provided, including eyewash/shower stations and multiple exits. Equipment protection is provided by equipment controls. Fire protection is also provided as fire extinguishers, flame arrestors, fire hose stations, grounding on flammable liquid lines, and nitrogen blanketing of solvents tanks.

The Tank Storage and Treatment Facility is depicted in plan views on Drawing B511-D-P20 and Drawing B511-B-BL1.

## D-2c Process Description

The following provides a discussion of the process overall; a discussion and outline of filling, transfer and treatment procedures is also provided. Actual operating procedures will be developed during equipment purchase and construction, along with associated operator log sheets.

The facility receives liquid wastes by tanker truck or from the leachate storage/treatment impoundments. The tanker trucks would deliver liquid wastes from generators or from any internal facility sump, containment, surface impoundment vacuuming or drum decanting operations.

Transfers of liquid wastes from the facility are by the direct pipe runs to the batch tanks in the Stabilization/Fixation Facility or by tanker truck for off-site treatment/disposal at an approved facility.

The tanks and their capacities are as indicated in Table D-2-1. The tank schedule shown on Drawing B511-B-BL1 indicates tank dimensions and materials of construction.

These tanks are all filled only by tanker truck with the exception of the aqueous waste, neutralization, and oils and oil sludge tanks. The aqueous waste tank also receives leachate from the lagoons. The neutralization tank is fed by the alkali, acid, and aqueous tanks, only. The oils and oil sludge tanks, can be filled by tanker truck and have an interconnection primarily intended for mixing the sludge with oil to improve the pumping properties.

Each tank has a dedicated discharge pump. A recycle line is provided on the discharge lines to turnover the tank contents for representative

TABLE D-2-1

TANK FARM STORAGE/TREATMENT FACILITY TANK LIST

| Tank Name | Capacity (gal) | Purpose |
|---|---|---|
| Alkali Tank (T-1) | 15,000 | storage |
| Acid Tank (T-2) | 30,000 | storage |
| Neutrialization Tank (T-3) | 10,000 | treatment |
| Halogenated Solvents Tank (T-4) | 15,000 | storage |
| Non-Halogenated Solvents Tank (T-5) | 15,000 | storage |
| Oil Sludge Tank (T-6) | 30,000 | storage |
| Aqueous Tank (T-7) | 15,000 | storage |
| Oils Tank (T-8) | 30,000 | storage |

sampling from the sample ports provided on each recycle line for mixing and, prior to transfer, to assure a homogeneous mixture is achieved.

Filling pumps are standardized at 100 gallon per minute, while transfer pumps are 25 gallons per minute. These capacities allow for a reasonable unloading time, but transfer movements, sometimes involving treatment,will be slower for better process control. A typical 10,000 gallon tanker would be emptied in approximately 1-1/2 hours. A 5,000 gallon transfer between the oil sludge and oils tank or to the neutralization tank would require approximately 3-1/2 hours.

All tanks have provisions for direct transfer to the Stabilization/Fixation Facility, excepting the alkali and acid tanks. The alkali and acid tank contents have to be treated in the neutralization tank prior to transfer to the Stabilization/Fixation Facility.

The oils (T-8), oil sludges (T-6), non-halogenated (T-5) and halogenated solvents (T-4) tanks are segregated for transfer, each with separate transfer piping, to the Stabilization/Fixation Facility's batch tank (T-9) for materials and composition compatibility. Tank T-9 is fiberglass reinforced plastic.

The neutralization (T-3) and aqueous (T-7) tanks transfer to the Stabilization/Fixation Facility's batch tank (T-13). Tank T-13 is stainless steel for materials compatibility with this waste group.

D-2c(1) Tank Filling and Discharge to Tanker Truck. The tank farm arrangement divides the tanker truck loading/unloading interface down the east-west center line of the facility. This arrangement results in the separate southern and northern truck unloading and loading areas, each serving a group of tanks.

Filling pumps, local to the two truck unloading/loading stations, provide for pumping to tanks from tanker trucks not having dedicated transfer pumps. These pumps have a capacity of 100 gallons per minute. Bypass piping is provided for tanker trucks having pumping provisions.

All filling lines have strainers for removal of large objects and protection of piping and pumping systems.

The filling caps have individually keyed locking caps to provide waste compatibility and overfilling protection. This administrative control is discussed in Section D-2f, below.

The northern truck unloading/loading station serves the acid (T-2), halogenated (T-4), and non-halogenated (T-5) tanks, with the respective filling pumps P1-T2, P1-T4 and P1-T5.

The southern truck unloading/loading station serves the alkali (T-1), oil sludge (T-6), aqueous (T-7) and oils (T-8) tanks, with the respective filling pumps P1-T1, P1-T6, P1-T7 and P1-T8.

The following is an outline of the filling procedures:

- ground tanker truck (ignitible wastes);
- operator and laboratory examine waste manifest form, issue locked filling cap key;
- operator prepares waste movement form, records inventories and initial levels;
- check high level alarm/interlock;
- align valving for facility pump or tanker pump use;
- vent and prepare tanker for unloading;
- commence tank filling while monitoring;
- operator shuts down pumping on desired level in tank or emptied tanker;
- operator records final level in tank;
- tanker disengaged and filler cap locked;
- filler cup key returned to laboratory with waste movement form;
- tanker grounding removed.

Where discharge to a tanker truck is desired for off-site treatment/disposal at an approved facility, the following outlines the procedures to be followed:

- operations and laboratory personnel prepare waste movement form and arrange manifest documents;
- fill cap key is issued by laboratory;
- tanker truck is grounded;
- tanker truck is vented and prepared for filling;
- commence tanker truck filling while monitoring level on tank and tanker truck;
- operator shuts down pumping on desired transfer to tanker;
- operator records final level in tank;
- tanker disengaged and filler cap locked;
- filler cup key returned to laboratory with waste movement form;
- tanker grounding removed.

The aqueous tank (T-7) is also filled from the leachate storage/treatment impoundments, as necessary. The leachate will in turn be directed to the Stabilization/Fixation Facility via the aqueous waste tank. An outline of the procedure to be followed is as follows:

- laboratory personnel prepare waste movement forms for the leachate, including aqueous waste tank contents compatibility check;
- the inventory of leachate to be transferred is determined based on available storage volume in the aqueous waste tank and indicated on the waste movement form;
- laboratory issues key for both leachate transfer and aqueous tank filler locking caps;
- operations personnel install interconnecting hose between above two caps;
- operator aligns valving;
- operator initiates pumping at leachate lagoon pump station while monitoring time versus inventory to be transferred (pump operates at 250 gallons per minute);
- after transfer is completed, final level of tank recorded on waste movement form;
- filler caps locked and keys and waste movement forms returned to laboratory.

D-2c(2) Oils-Oil Sludge Internal Waste Liquid Transfer. The transfer pumps on the oils tank T-8 can be used to transfer oils to the oil sludge Tank T-6 (refer to Drawing B511-D-SK-23). This provision has been provided to allow for thinning the oils sludge to facilitate pumping or to provide additional storage in the oils tank when needed and where the oils and oil sludge tank contents are compatible.

An outline of the procedure to be followed for inter-tank transfer is as follows:

- operations personnel check initial inventory levels with records;
- laboratory personnel prepare waste movement form including checking compatibility and specifying inventory to be transferred;
- operator aligns valving;
- transfer pumping commences while levels are monitored
- on completed transfer, operator shuts down pump and records final levels on waste movement form;
- valving realigned and waste movement form delivered to laboratory for records storage.

D-2c(3) Treatment Processing/Neutralization Tank Operation. The neutralization tank (T-3) is primarily intended for pH conditioning of the predominant volumes of acid waste (T-2) anticipated to be delivered to the site to facilitate their stabilization/fixation. The neutralization tank draws lime slurry off the lime slurry recycle system in the Stabilization/Fixation Facility to raise the pH of the acid wastes.

In addition, the contents of the alkali tank (T-1) can be added to the neutralization tank to condition the pH of the acid wastes. Under some circumstances, e.g., alkali waste of high pH, it may be desirable to condition the alkali waste.

The neutralization reaction chemistry will vary depending on the waste feed compositions, potentially involving precipitation of the resultant metal salts.

Provisions for transfer from the aqueous waste (T-7) to the neutralization tank are also provided to allow for conditioning of aqueous waste or mixing with alkali or acid wastes.

Acid or alkali wastes to be stabilized/fixed need to be processed through the neutralization tank prior to transfer for stabilization/fixation. This piping arrangement is depicted on the alkali and acid tank P&ID Drawing B511-D-SK20. The neutralization tank is depicted on P&ID Drawing B511-D-SK21.

An outline of the procedure to be followed for neutralization tank operation is as follows:

- laboratory prepares waste movement forms including sampling and testing, if necessary, to determine waste/lime mixtures;
- waste and lime inventories for processing specified on waste movement form;
- operations personnel check operation of alarms/interlocks;
- initial levels in tanks recorded on waste management form;
- check availability of and activate lime slurry recycle system;
- align neutralization feed valving and start up mixer and set transfer pump in recycle mode to engage pH sensor;
- commence waste feeding while monitoring levels for intended inventory transfer (acid wastes transferred first);
- record inventory of transferred wastes on waste management form;
- lime slurry or alkali addition in batches allowing for homogeneous mixing and neutralization reactions, record temperature and pH;
- on reaching desired pH, shut down lime slurry system;
- record final pH and levels in tanks on waste movement form and return to laboratory for record keeping;
- shutdown recycle, maintain mixer active while contents in tank.

D-2c(4) Transfer for Stabilization/Fixation Processing. The primary transfer mode for waste liquids held in the tank farm is to the Stabilization/Fixation Facility. All the tanks have dedicated pipe runs to the

Stabilization/Fixation Facility, except for the acid and alkali tanks. The waste in these tanks must pass through the neutralization tank to assure pH adjustment to the range promoting the stabilization/fixation process, prior to transfer. The batch tanks in the Stabilization/Fixation Facility have additional provisions for pH conditioning with the lime slurry, as described in Section D-9; however, this is intended for final adjustment, if necessary.

Waste liquids designated for stabilization/fixation are tested as part of the pre-acceptance testing, described in Section C-3, to assure stabilization/fixation can be achieved and to specify additive mixture ratios. Where mixing, pH conditioning or other suspected compositional changes are judged by the laboratory to have altered the composition significantly, additional stabilization/fixation verification tests will be performed. (All samples drawn will be from the recycle line sampling ports after adequate recycling has assured a homogeneous mixture resulting in a representative sample.)

The batch tanks, of 2,000 gallons capacity, will receive waste liquids from the 10,000 to 30,000 tank farm tanks in batches for stabilization/fixation processing. Prior to transfer, tanks are to be put in a recycle mode to turn over the contents of the tank, assuring delivery of a homogeneous waste liquid batch.

The oils and oil sludge tanks, T-6 and T-8, have provisions for drawing off at three levels (see Drawing B511-D-SK23). Where this is desired, the contents of these tanks will not be mixed.

Transfer of waste liquids to the Stabilization/Fixation Facility requires operational procedures at both facilities.

An outline of the procedure for preparing the batch tanks for waste liquids receipt is provided in Section D-9c(5). The detailed operating procedures for this transfer will combine the above with the following outline of the tank farm waste liquids transfer to the Stabilization/Fixation Facility procedure:

- samples are taken, where necessary, for pre-stabilization/fixation testing (adequate recycling is performed to ensure a homogeneous mixture resulting in a representative sample);
- laboratory personnel prepare waste movement forms indicating the inventory and source or waste liquids;
- tank is put into recycle mode for homogeneous mixing;
- valving aligned for transfer to readied batch tank;
- shut down on completion of transfer, record final levels on waste movement form and return form to laboratory..

## D-2d Description of Tanks

The tanks in the tank farm have been designed for their intended usage; to accommodate the waste classes and liquid volumes delivered and compositions and to prevent collapse or rupture with suitable design safety factors applied.

The tanks are to be fabricated of carbon steel, epoxy-coated carbon steel, low carbon content stainless steel and fiberglass reinforced plastic (FRP) depending on the anticipated waste class contents of each. The applicable fabrication codes employed for these tanks, specifying wall and bottom plate thickness and corrosion allowances determination, are as follows: American Petroleum Institute (API) 650, "Welded Steel Tanks for Oil Storage" and American Society for Testing and Materials D4097, "Contact Molded FRP Tanks." All tanks are at atmospheric pressure. Assumed tank service lives are conservatively estimated as eight (8) years. Waste liquid specific gravities have been conservatively assumed to be 1.5 throughout.

Tank corrosion testing and integrity inspection is described in Section F-2.

All tank bottoms are fully supported by the tank pedestal. Tank pedestal reinforcing and tank anchor bolt designs were developed in accordance with the local building codes, standard structural design practices, and geotechnical data. In particular, a maximum wind loading criteria of

35 pounds per square foot-horizontal has been applied to anchor calculations.

The fabrication and geotechnical calculations are included in Appendix D-4.1. Drawings B511-B-T1 through T8 are the mechanical series drawings depicting the eight tanks. Division VII of the technical specification covers the tanks.

All the tanks have top and side access man-ways, drains and ladders for maintenance. Platforms, ladders and railings are per OSHA standards.

D-2d(1) Alkali Tank (T-1). The alkali tank is depicted on Drawing B511-B-T1. The alkali tank is intended for storage of alkaline and caustic aqueous-based waste liquids. The tank has a capacity of 15,000 gallons; diameter 12 feet, height 18 feet 9 inches. The alkali tank is to be constructed of A-285 grade C carbon steel, in accordance with API 650, with a minimum wall thickness of 3/16 inch, which includes a corrosion allowance of 1/64 inch per year over the assumed eight year service life. An epoxy coating, specifically developed for alkali storage, will be applied; "Plasite 9570". This coating is designed for caustic solution resistance combined with chemical resistance to a range of acids and solvents.

The tank has eight (8) nozzles on its roof including the man-way and a spare. Associated piping is carbon steel with full port ball valves. Pumps for the alkali tank are of the centrifugal, in-line variety.

D-2d(2) Acid Tank (T-2). The acid tank is depicted on Drawing B511-B-T2. The acid tank is intended for storage of aqueous-based acid waste liquids. The tank is the largest aqueous-based waste tank at 30,000 gallons, due to historical waste receipt volumes indicating predominantly acid waste liquids. Tank diameter is 12 feet, height 36-1/2 feet. The tank is to be construction of FRP for compatibility with the waste acids, in accordance with ASTM 4097, with a minimum wall thickness of 1-3/16 inches. Bottom head minimum thickness is 3/8 inch.

The tank has eight nozzles on its roof, including the man-way and a spare.

Associated piping is also FRP with diaphragm valves. Pumps for the acid tank are centrifugal.

D-2d(3) Neutralization Tank (T-3). The neutralization tank is depicted on Drawing B511-B-T3. The tank is intended for treatment of acid, alkali and aqueous waste liquids where necessary to change their hazard characteristics and promote stabilization/fixation processing. The tank has capacity for 10,000 gallons; diameter 10 feet 3 inches, height 17 feet 4 inches. The neutralization tank is to be construction of FRP to accommodate the waste liquids, in accordance with ASTM 4097, with a minimum wall thickness of 1/2" and bottom head of 1/4 inch.

The tank has twelve nozzles on its roof including the man-way and a spare. An agitator is to be installed in the centerline nozzle with reinforcing to be designed by the tank fabricator. A temperature thermowell will extend down from one nozzle into the tank. The temperature in the tank will not exceed the ASTM 4097 design standard of 180° Fahrenheit as demonstrated in the worst-case temperature rise calculation included in Appendix D-4.1. Associated piping is FRP with diaphragm valves. Pumping is performed by a centrifugal pump.

D-2d(4) Halogenated Solvents Tank (T-4). The halogenated solvents tank is depicted on Drawing B511-B-T7. The tank is intended for storage of halogenated organic-based solvents. The tank has capacity for 15,000 gallons; diameter 12 feet, height 18 feet 9 inches. The halogenated solvents tank is to be constructed of AISI-316L low carbon stainless steel, in accordance with API 650; minimum wall thickness is 3/16 inch with bottom head 1/4 inch.

The tank has ten nozzles on its roof including the man-way and a spare. This man-way, on the roof, is designed with an explosion relief cover, providing backup for the pressure relief valve. Both feed and recycle is by dip pipes extending to within 9 inches of the bottom. A thermowell also extends down to the bottom of the tank. This tank is to be nitrogen blanketed with two nozzles dedicated to sensing and filling, respectively. The nitrogen manifold will be on or local to the tank.

All associated piping is grounded stainless steel with full port ball valves. Pumps are in-line centrifugal.

D-2d(5) <u>Non-Halogenated Solvents Tank (T-5)</u>. The non-halogenated solvents tank is depicted on Drawing B511-B-T4. This tank is intended for storage of non-halogenated organic-based solvents to allow for their segregation from the halogenated solvents. The tank is constructed as a duplicate of Tank T-4, the halogenated solvents tank.

D-2d(6) <u>Oil Sludge Tank (T-6)</u>. The oil sludge tank is intended for storage of waste oil sludges. The tank has capacity for 30,000 gallons; diameter 16 feet, height 21 feet 4 inches. The tank is to be constructed of A-285 grade C carbon steel in accordance with API 650, with a minimum wall thickness of 1/4 inch and base plate 3/8 inch.

The tank has three discharge nozzles at varying heights along the side (upper discharge nozzle valving is chain operated for operated access) to allow for discharge of potentially stratified layers. Eight nozzles are provided on the roof including the man-way and a spare. This man-way, on the roof, is designed with an explosion relief cover, providing backup for the pressure relief valve.

The tank is not directly vented, but employs a conservation valve for controlled air holdup in the vapor space. This design minimizes vapor evaporation to the atmosphere.

All associated piping is carbon steel with full port ball valves. The pumps on this sludge tank are air powered diaphragm pumps, assuring sludge transport.

D-2d(7) <u>Oils Tank (T-8)</u>. The oils tank is depicted on Drawing B511-B-T6. The oils tank is intended for separate storage of less viscous waste oils. The tank is to be constructed as a duplicate of the oils sludge tank, including provisions for discharge from three levels.

The pumps are positive displacement.

D-2d(8) Aqueous Waste Tank (T-7). The aqueous waste tank is depicted on Drawing B511-B-T8. The aqueous waste tank is intended for storage of aqueous-based liquid wastes of neutral pH range. The tank is to be constructed as a twin of the alkali tank (T-1) excepting the requirement for coating.

D-2e Tank Management Practices/Administrative and Process Controls

The tank farm operation and design incorporates administrative and process controls to assure waste compatibility, prevent overfilling of tanks, and to prevent uncontrolled conditions during treatment in the neutralization tank.

D-2e(1) Waste Liquids Segregation and Compatibility Control. The tank farm design utilizes multiple tanks each with dedicated filling and transfer piping to assure waste segregation and compatibility.

A color code system will be applied as a common identifier for tanks, piping and waste stream identification. The color code system will be as follows:

| Color | Service Classification |
|---|---|
| Blue | Nitrogen |
| Red | Fire Water |
| Green | Potable Water Showers/Eyewashes |
| Yellow | Lime |
| | Process Waste Lines: |
| Yellow/Black | Acids |
| Yellow/White | Caustics |
| Yellow/Green | Aqueous Wastes/Neutralized Liquids |
| Orange | Halogenated Solvents |
| Orange/Black | Non-halogenated Solvents |
| Orange/Aluminum | Oils |
| Orange/Green | Oil Sludges |

(0630B)

This code follows the guidelines set out in ANSI A13.1 and will be applied to equipment per section 5020 of the technical specification.

Administrative control will be applied to protect this arrangement in the form of individually keyed locked filler caps. The tagged and color-coded keys are to be maintained in the laboratory. Any tank filling will require operations personnel to request the appropriate key from the laboratory. The laboratory personnel will serve as an administrative check examining the manifest forms prior to issuing the key. The operations personnel also serve as an administrative check by confirming the waste and key code correspondence.

In addition, were incompatible liquids to be added to the solvents tanks which could cause heat generating reactions (e.g., oxidizing agents) despite the above described controls, a process control is provided. Temperature is monitored in these tanks and both a high alarm activated and the feed pump shut down on heat generation.

D-2e(2) Tank Overfilling Protection. Both administrative and process controls are provided to protect against tank overfilling and the resulting spillage.

Administrative controls include the locked filler caps preventing unauthorized filling. The filling procedure also requires inventory reconciliation by operations personnel, verification of available storage and volume to be transferred to the tank.

Process controls include level indication and separate high-level monitoring alarm and interlocking to shut down filling pumps. This control loop is uniformly included on all tanks including interlocks on transfer pumps in the tank farm from the batch tanks in the stabilization/fixation facility. Were the redundant administrative and process controls to fail, overflow lines on the tanks are designed to direct the spillage in a controlled manner to the containment areas.

The overflow line is depicted on each tank P&ID, e.g., Drawing B511-D-SK22 for the solvents tanks and on the piping section, Drawings B511-D Series P. The design utilizes a separate drop leg extending down to within one foot of the base of the tank. An elbow extending into the tank at the flange, improves the height at which overflow is initiated, maximizing the tank volume use for nominal holdup. The use of the separate drop leg prevents the use of the vent as an overflow and contamination of the flame arrestor and conservation valving on the nitrogen blanketed tanks upon overflow. Further, the overflow is directed in a controlled manner to the base of the tank and out to the containment; splashing of overflow onto the tank from vent usage as overflow is prevented.

D-2e(3) Treatment Processing Control. Treatment processing in the neutralization Tank (T-3), is controlled by both administrative procedural controls and process controls.

Administrative controls include the use of the waste movement form required to be prepared by the laboratory personnel prior to any treatment operations in the tank. As part of the waste movement form preparation, the inventories of waste liquids to be treated are specified, including laboratory tests on samples, if necessary. Further, procedures will require batch filling and lime addition to allow neutralization reactions to stabilize. While laboratory preliminary testing and processing controls will be required prior to treatment, the available combination of feeds all tend toward raising the pH of the waste liquid to make it more suitable for stabilization/fixation processing. In addition, by batch processing, the leveling out of the typical buffer curve will further operational.

Process controls are depicted on Drawing B511-D-SK21, the neutralization tank P&ID. High level alarm and interlock on the acid, alkali and aqueous transfer pumps is provided. A high pH alarm is provided to alert operations personnel to shutdown lime addition and/or feed transfer. Temperature monitoring includes high temperature alarm and interlock to shut down waste feed pumps.

These controls will serve to maintain treatment processing in the neutralization tank within controlled conditions.

D-2f <u>Secondary Containment/Spill Prevention</u>

The Tank Storage and Treatment Facility design incorporates secondary containment and spill prevention designs to minimize the possibility of unplanned sudden or non-sudden releases of hazardous waste to the environment. Secondary containment is provided for spill prevention; around the tanks, in the truck unloading areas, and on the pumps. In addition, a leak detection system is incorporated into each tank pedestal to provide early warning of tank leakage, if any.

D-2f(1) <u>Truck unloading station areas.</u> The truck unloading areas are raised above grade approximately 2 feet on the sides and one foot at the entrance and exit ramps.

These slopes, in conjunction with the 6 inch ramps and curbs serve to both prevent run-on and run-off. The entire truck unloading area is roofed to control run-on from rainfall. All spillage from truck unloading operations will collect in the catch basins, draining off the epoxy coated and sloped concrete surface. The catch basis design allows for local holdup and collection of minor spills and gravity drainage to the stormwater retention impoundment in the event of a large spill. All drain pipe and concrete section connections are sealed with water stops us described in Sections 2170 and 3010 of the technical specifications and depicted on Drawings B511-B-SL2 and B511-B-S6.

D-2f(2) <u>Tank Containment.</u> Secondary containment is provided around each tank pedestal with sloped epoxy coated floors draining to a low point sump. This arrangement would retain the waste liquid segregation, in the event of a spill or tank rupture, originally provided for by tank.

The use of a sump without a pump, in each containment, introduces an administrative control check by requiring plant operator decision on the transfer of the spill holdup. The spill would, in any case, need to be vacuumed into a tanker truck for transfer to the Stabilization/Fixation Facility directly or for holdup in another tank (this waste transfer would require a waste movement form).

Drawing B511-B-BL1 provides a schedule of the containment area volumes and percent over capacity with respect to the tank contained. It can be seen from the schedule that containment area capacities are at least twenty percent over tank volumes. Drawing B511-B-BL6 depicts a sump detail along with a cross-section of the typical four-foot high eight-inch thick containment wall.

The sump and containment walls are keyed and sealed.

D-2f(3) Pump Drip Pans. The pumps in the Tank Storage and Treatment Facility each have drip pans and hoods as depicted on Drawing B511-D-M23. These stainless steel drip pans have sufficient holdup capacity to prevent drippings or leakage to be contained. The hood will be constructed over the drip pans to prevent entry of rain/wash water that would occupy the available holdup. During the inspections, performed per Section F, the holdup will be drained and transferred to a holding drum. This arrangement provides containment around pumps in the tank containment areas and at the truck unloading area pads. In particular, the use of drip pans for the pumps located in the containment areas prevents mixing of pump dripping with holdup in the containment. The pump dripping will not result in a hazard classification for otherwise non-hazardous containment holdup.

D-2f(4) Tank Leak Detection System. The tanks pedestal design, depicted in Drawing B511-B-S4, shields the bottom of the tanks from the visual leak detection inspection discussed in Section F. Therefore, a granular bed and drain pip system has been designed into the pedestals (see Drawing B511-B-BL6). This arrangement serves as a leak detection system for the tanks. During the course of inspections the drain pipe is opened and drained in a controlled manner. Holdup would indicate a leak problem, requiring administrative response and isolation of the tank for repair.

D-2g Safety/Fire Protection

The tank farm storage/treatment facility has been designed to provide for personnel and equipment safety.

The dedicated water tank and eyewash/shower system, serving the stabilization/fixation building also, is located at this facility. This system is depicted on Drawing B511-D-SK27. Drawing B511-C-P2 provides a detail of the eyewash/shower stations.

The system's dedicated water tank (T-17), of volume 1,400 gallons, is located east and adjacent to the tank farm. The tank is to be installed underground in order to prevent the eyewash/shower water from reaching elevated temperatures from exposure to the sun. The system operates by a jockey-main pump system, whereby a flow is continuously recycled and on demand, a booster pump kicks on. Three (3) eyewash/shower stations are located at personnel traffic locations; one at either end of the catwalk, at the filling pump stations which are readily accessible from the truck unloading/loading stations, and one at the center of the catwalk.

The catwalk design and tank ladder arrangements incorporate OSHA requirements including railings. Personnel exists are provided by two stairs at either end of the catwalk and by a ladder arrangement over the containment walls at each tank containment area, to facilitate emergency evacuation.

Fire protection is provided by dry chemical fire extinguishers and fire hose stations at each truck unloading/loading area. In addition, all piping potentially carrying flammable liquids are grounded, including provisions for tanker truck unloading/loading station ground jumpers, per Section 6010 of the technical specification.

The tank farm is classified as a Class 1, Division 1, Group C fire hazard area per the National Electric Code (NEC). All electrical equipment and fixtures will be explosion-proof, and the oil and oil sludge tanks and solvents tanks have flame arrestors on the vent valving. The solvents tanks are also blanketed by nitrogen, from a compressed nitrogen tank T-16 with manifold at each tank, to prevent air entry into the vapor spaces, creating a combustible atmosphere.

Equipment safety devices include pressure relief valving across the positive displacement pumps which continue to create pressure on "dead-heading" and on the nitrogen-blanketed solvents tank. Further, the man-ways on the solvents and oils and oil sludge tanks are designed as explosion relief vents.

Low level shut-off interlocks on discharge pumps are also provided to protect against cavitation damage to these pumps.

APPENDIX D-2.1

TANK STORAGE AND TREATMENT FACILITY

Tank Calculations

This material was previously submitted on January 27, 1986; Response to Technical Review of Proposed Tank Storage and Treatment Facility.

APPENDIX D-2.2

TANK STORAGE AND TREATMENT FACILITY

Technical Specifications

This material was previously submitted on January 31, 1986; PROTECO PROJECT MASTER DOCUMENTS LIST - Plans and Specifications.

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## D-3 Decant Facility

A percentage of the liquid wastes received at PROTECO are expected to arrive in 55-gallon drums. Included in the Container Storage Facility will be a decant system for aqueous wastes and oils in drums.

### D-3a Decant Facility Description

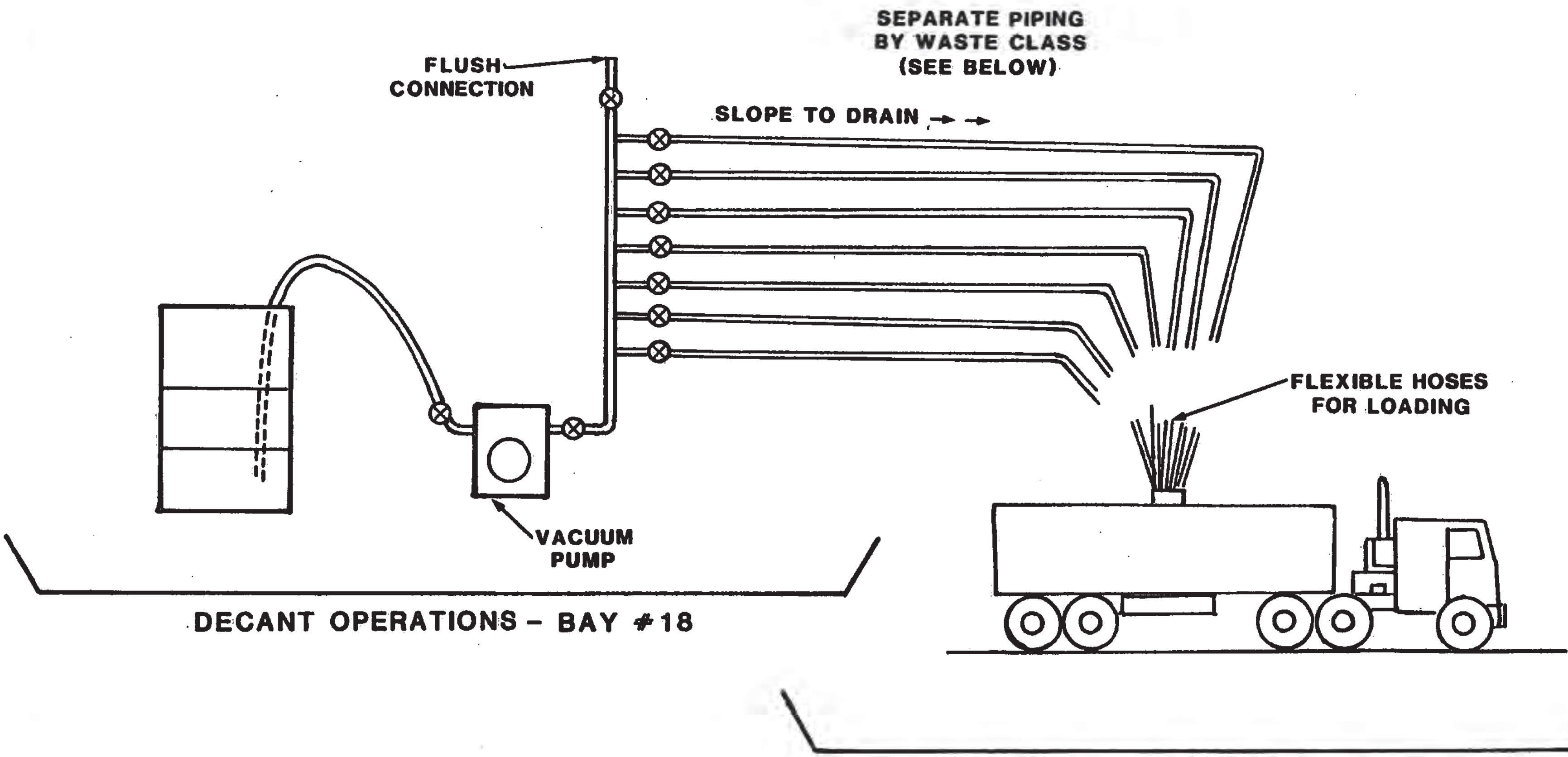
The location of the Decant Facility will be in Bay No. 18 of the Container Storage Facility. The Decant Facility will be designed to safely remove liquids from containers, with operations being conducted on a batch basis by waste class. The proposed Decant Facility is capable of processing a full range of aqueous and organic liquid waste except for cyanides over 100 ppm and/or sulfides over 100 ppm, and some reactives.

The proposed decant operations will process the same general categories of liquid wastes as are stored in the Container Storage Facility and as are managed in the Tank Farm/Treatment facility.

### D-3b Decant Facility Process

Figure D-3-1 is a process flow diagram of the Decant Facility. Containers scheduled for decanting will be transported from the storage bay and placed in the Decant Bay, No. 18. No more than two containers will be transferred to this Bay at one time. Valving will be preset by the waste class being decanted. (Decant operations will be prescheduled and conducted on a batch basis, i.e., when a storage bay contains a sufficient quantity of liquid wastes to be decanted, decant operations will be scheduled in advance for that waste class.)

Liquids decanted will be pumped to a tank truck which will, in turn, be used to transport wastes and discharge them into the Tank Farm Storage/Treatment Facility. As shown in Figure D-3-1, the piping is specific for each waste class. This class specific piping prevents mixing of incompatible wastes. Liquids requiring special handling and treatment may be pumped directly into the batch tank(s) in the Stabilization/Fixation Facility.




WASTE CLASSES & COLOR CODES

| | |
|---|---|
| YELLOW/BLACK | ACIDS |
| YELLOW/WHITE | CAUSTICS |
| YELLOW/GREEN | AQUEOUS WASTES/NEUTRALIZED LIQUIDS |
| ORANGE | HALOGENATED SOLVENTS* |
| ORANGE/BLACK | NON-HALOGENATED SOLVENTS* |
| ORANGE/ALUMINUM | OIL* |
| ORANGE/GREEN | OIL SLUDGES* |

* These classes require grounding of Tanker, Piping, Pump, Building and Container, following appropriate design standards and field grounding sequence.

FIGURE D-3-1

DECANT FACILITY
PROCESS FLOW DIAGRAM

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At the end of each batch operation, the decant pump will be pumped with wash water or other appropriate wash liquid if incompatible wastes were previously pumped. Appropriate connections for flush lines will be included in the design of the decant units.

Separate loading hoses at the loading dock will direct the liquid to the tank truck. As described in the Waste Analysis Plan (Section C), compatibility testing is done before transferring waste materials to any storage tank or process vessel.

The Decant Facility has a number of safety features designed to promote safe and efficient operation. All electrical devices within the process area will be explosion-proof. A fume hood will be provided at the pump station to provide positive removal of vapors from the operating area. Emergency safety showers are provided, and operators will wear appropriate respiratory and splash protection gear and protective clothing during decanting operations. Emergency response fire-fighting and first aid equipment are also located at the facility. Also, all operating personnel undergo operating and safety training. Further procedures to prevent hazards around the decant facility are described in Section F of this document.

## D-3c Secondary Containment for Decant Tank

Secondary containment in the Decant Facility will be the same as that provided for all bays in the Container Storage Facility, with liquids being managed as follows:

a. after each batch operation, the Bay No. 18 will be inspected to determine if there are any liquid or solid spills.

b. if spillage has occurred, cleanup and decontamination will be carried out before proceeding with the next batch, with any resulting liquids being managed as per the appropriate waste class, subject also to on-site laboratory approval. Note - pump flush waters will be similarly managed.

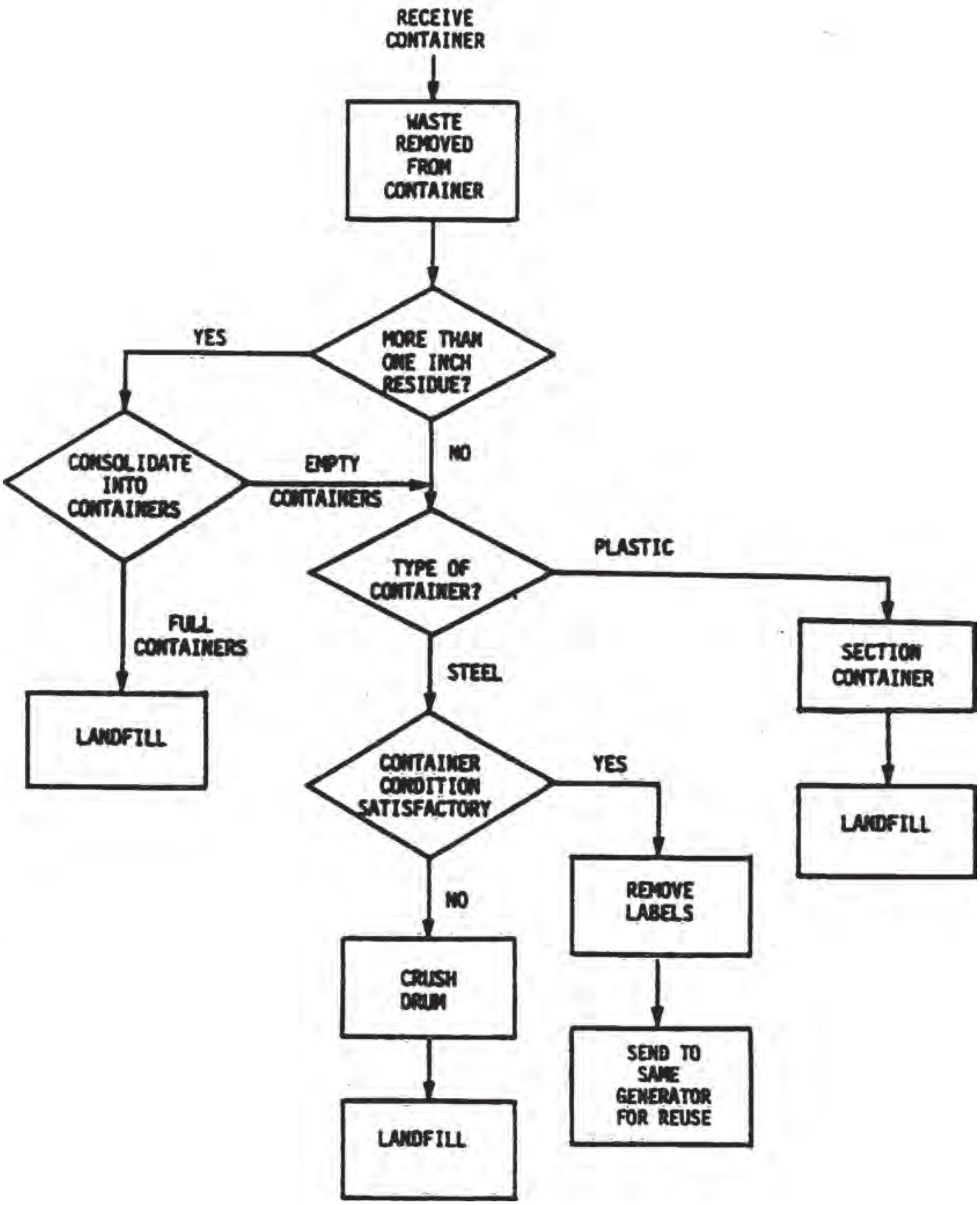


FIGURE D-3-2

EMPTY CONTAINER PROCESSING FLOW CHART

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## D-4 Surface Impoundments

There are three (3) surface impoundments proposed for the PROTECO facility. These are Leachate Ponds A and B, situated between Landfills I and II, as shown on Drawing No. B511E-L20; and a Stormwater Retention Impoundment associated with the Tank Farm and Container Storage Buildings located near the facility entrance, shown in plan on Drawing No. B511-C-SL3. In addition, a lagoon, called the sediment Basin, is located adjacent to the Leachate Ponds and shown on the plan drawing. The Sediment Pond, serving solely for the control of surface water runoff, is not classified as a surface impoundment and a discussion of it is not presented.

The construction and geotechnical details of the surface impoundments parallel the proposed landfill facilities; sections of the landfill description, section D-6, and the associated drawings and Appendices (technical specifications, Quality Assurance Manuals) are referenced as necessary.

### D-4a List of Wastes

Ponds A and B will contain only leachate from the active landfill operations; the stormwater retention impoundment will contain any contaminated surface run-off from the Tank Farm and Container Storage Area only and will also function as an emergency spill containment facility for these units.

### D-4b Liner Exemption Requests

The impoundments will be fully lined with dedicated leak detection system, as described below. No exemptions are requested.

### D-4c Liner System, General Items

D-4c(1) Liner System Description. Each pond will be double, synthetic lined in similar fashion to the Landfill Areas I and II. The base of the pond liner system will consist of the following items in order of their occurrence with depth:

1. A non-woven filter fabric (as specified in Division IV Geomembranes, section 4030 geotextiles, of the Landfill technical specification) will be secured in position at the top edge with wire rope and weighted at the bottom with chain. This arrangement is depicted on the Leachate Collection System Drawings, Series B511-I.

2. An 80-mil high density polyethylene liner (HDPE) serves as the primary liner. The liner material is specified in Section 4010, Division IV, of the Landfill technical specification.

3. Fifteen inches of granular material (as specified in Section 2010 Earthwork, Division II Site Work, of the Landfill technical specification) that will function as the leachate detection zone. Perforated PVC, pipe specified in Section 5030, Division V, of the above same specification, within this zone will connect to observation manholes located outside the pond perimeter.

4. An 80-mil HDPE secondary liner

5. Three feet of compacted clay with a maximum permeability of $1 \times 10^{-7}$ cm/second; (as specified in Section 2010 Earthwork, Division II Site Work, of the Landfill technical specification)

Sideslopes within the ponds will be similarly lined, except that the granular leachate collection zone will be replaced with a geonet material of comparable drainage capacity. Drainage net material is specified in Section 4020, Division IV, of the Landfill technical specification.

D-4c(2) <u>Liner System Location Relative to High Water Table</u>. Measured groundwater levels throughout the site are shown on the geologic sections of Drawing Nos. B511-E-L5 through L8. Comparison of these data with the proposed pond inverts indicate that the groundwater level is well below the bases of the proposed impoundments; therefore, hydrostatic uplift on the liner systems is not anticipated.

D-4c(3) <u>Loads on the Liner System</u>. Maximum stresses in the liner system will occur during installation and subsequent filling of the ponds. Installation stresses are expected to be similar to those generated during landfill liner installation; ponded fluid loads will be much less than the Landfill I and II liner loads. Thus, stresses in the HDPE pond liner are expected to be minimal (see Section D-6c(3)).

D-4c(4) <u>Liner System Coverage</u>. Details of the liner systems for the three ponds are presented on the Leachate Collection System Drawings, Series B511-I, and demonstrate that the liners will be installed to cover all surrounding earth likely to be in contact with waste or leachate.

D-4c(5) <u>Liner System Exposure Prevention</u>. The top HDPE liner will be completely covered by a non-woven geotextile fabric; depicted on the details contained in the Leachate Collection System drawings.

D-4d <u>Liner System, Foundation</u>

D-4d(1) <u>Foundation Description</u>. A discussion of the general site geology, as it relates to all site foundation conditions is presented in Section D-6d(1). With respect to the pond foundations, in-situ material underlying these structures is comprised of a clay, the Juana Diaz Formation, which is basically characterized as a hard, relatively incompressible soil. The stormwater retention impoundment at the Tank Farm will be founded in this substrata. Leachate Ponds A and B will be founded in compacted soil fill above the in-situ material. This fill is anticipated to be generated from the required excavations into the clay substrata at Landfills I and II.

D-4d(2) Subsurface Exploration Data. Geologic cross-sections pertinent to the design of the overall facility are presented on Drawing Nos. B511-E-L5 through L8. Drilling logs for all site borings are presented in Appendix D-6.1.

D-4d(3) Laboratory Test Data. Laboratory test data for soils pertinent to the foundation and embankment evaluation and construction plans are presented in Appendix D-6.2. A discussion of these tests is presented in Section D-6d(3).

D-4d(4) Engineering Analysis. Analysis of the pond system was confined to stability evaluations, as the bearing capacity and settlement potential can be assessed by reference to the landfill design.

D-4d(4)(a) Settlement Potential. Settlement of the hard clay-like substrata and compacted fill is expected to be minimal by inference to the loading conditions within the ponds and the results of the landfill calculations.

D-4d(4)(b) Bearing Capacity. The bearing capacity evaluation of the proposed landfills infer adequate bearing capacity for the pond systems.

D-4d(4)(c) Potential for Excess Hydrostatic or Gas Pressure. A general discussion which indicates minimal potential for excess hydrostatic or gas pressure is presented in Section D-6d(4)(d).

D-4e Liner System, Liners

D-4e(1) Synthetic Liners. The design includes two synthetic liners having the same dimensions and properties as follows:

- Thickness: 80 mil
- Type Material: High Density Polyethylene (HDPE)
- Brand Name/Manufacturer: Gundle; verification pending liner compatibility testing.

D-4e(1)(a) Synthetic Liner Compatibility Data: Complete data will be provided upon completion of study.

D-4e(1)(b) Synthetic Liner Strength. Complete data will be provided upon completion of study.

D-4e(1)(c) Synthetic Liner Bedding. Liner details, contained in the Leachate Collection System Drawings show that the secondary liner will be placed against the three foot thick compacted clay surface and will be covered by 15 inches of granular material. Calculations contained in Appendix D-6.3, Addendum to Geotechnical Evaluation, indicate that minimal stresses will be induced in the synthetic liner during placement of the granular material. Ground pressures expected by construction equipment are also limited by the construction specifications; Section 3 of the Quality Assurance Manual for the Installation of HDPE Geomembranes.

D-4e(2) Soil Liners. A three foot thick compacted clay liner will provide a uniform foundation for the secondary synthetic membrane at each pond. The clay will consist of re-compacted on-site material as permeability tests on re-compacted clay-like site soils (as presented in Appendix D-6.2) indicate that permeabilities less than $1 \times 10^{-7}$ cm/sec are attainable at near-optimum compaction. Compaction is specified in section 2010, Division II, of the Landfill technical specification.

D-4e(2)(a) Material testing Data. The materials testing data for soil liners is described in Section D-6e(2)(a).

D-4e(2)(b) Soil Liner Compatibility Data. Complete data will be provided upon completion of study.

D-4e(2)(c) Soil Liner Thickness. Pond units will have a double synthetic liner system. The soil liner serves to provide a base for the synthetic liner only.

D-4e(2)(d) Soil Liner Strength. Strength data from compacted site soil samples are included in the Addendum to Geotechnical Evaluation, Appendix D-6.3, and indicate that the compacted site soils have adequate strength for use within the landfills. Thus, by inference, they are adequate in their use for pond lining.

D-4f <u>Liner System, Leachate Detection System</u>

D-4f(1) <u>System Operation and Design</u>. The liner system (as described in Section D-4c(1)) contains a granular leachate detection zone that will be monitored by connections to an observation manhole located outside of the pond perimeter. The manhole will be constructed with an invert located four feet below the incoming leachate line to enable leak rate measurement, evaluation, and sampling, if desired. This arrangement is depicted on the Leachate Collection System drawings, series B511-I.

D-4f(2) <u>Equivalent Capacity</u>. Calculations demonstrating the equivalent capacity requirements are contained within the leachate system evaluation of Appendix D-6.3.

D-4f(3) <u>Grading and Drainage</u>. Grading and drainage has been provided for in the design. Detailed grading plans for the leachate collection/detection systems of the three surface impoundments are presented in the Leachate Collection System Drawings.

D-4f(4) <u>System Compatibility</u>. Complete data will be supplied upon completion of study.

D-4f(5) <u>System Strength</u>.

D-4f(5)(a) Stability of Drainage Layers. Bearing capacity calculations performed for the landfill units, as presented in Appendix D-6(3), infer adequacy for the pond units. All sloped surfaces will, likewise, be lined with geosynthetic and geonet materials that will be keyed into the top of the slopes to provide structural stability. This arrangement is shown on the details contained in the Leachate Collection System Drawings.

D-4f(5)(b) Strength of Piping. Identical piping to that used for the landfill units will be used in the pond units. Thus, piping strength is adequate by inference.

D-4f(6) Prevention of Clogging. Section D-6f(7) describes the design features employed to prevent clogging in the Landfill leachate piping. These same techniques are applied.

## D-4g Liner System, Construction and Maintenance

The construction and maintenance of the liner system is described in the Landfill discussion, Section D-6g, and is supported by the Liner Construction Quality Assurance Manuals.

## D-4h Prevention of Overtopping

D-4h(1) Design Features.

- Leachate Ponds A & B. The two ponds provide for a redundant system of leachate collection each providing capacity for the total design storage volume. Only one pond will be actively utilized at a time, and the second pond will provide automatic overtopping protection. Both ponds are designed to provide a two-foot freeboard and employ high level alarms to control the six (6) incoming leachate pump stations. A freeboard control pipe will be provided between the two ponds while maintaining the desired two-foot freeboard.

- Stormwater Retention Impoundment. This pond is designed to store: run-off from Tank Farm Secondary Containment Areas, transfered by manual pumping; liquid from a 100-year, 24-hour storm; and provide a minimum two-foot freeboard. A high level alarm will activate when the pond level reaches the maximum storage level that would not permit inflow from the design storm.

D-4h(2) Operating Procedure. Six leachate collection manholes/pump stations pump leachate to the grit chamber which in turn directs flow to either or both of the leachate ponds. Both the Grit chamber and each of the leachate ponds will be equipped with high level floats to automatically shut off the pumps at each of the (6) manholes in the event a high level mark is reached. Should the leachate level continue to rise it would set off an alarm in the site operator's office giving advance warning.

Each of the leachate ponds have a pump station situated within it, capable of transferring liquid from one pond to the other or to a riser in the tank farm receiving area. High level floats at the tank farm will control the pumps in the leachate ponds, shutting them down when a preset level is reached in a particular tank. A keyed overide will be provided and will prevent inadvertent pumping to the tank farm during transfer of liquids from one leachate pond to the other. In turn, each leachate pond will also be provided with a high level float to shut down the other pond's pumps during the process of transfering leachate.

D-4h(3) Overtopping Potential. Calculations are provided in Appendix D.6.5 that demonstrate that the capacity of the ponds to store the recommended design storm.

D-4h(4) Freeboard Requirements. Freeboard will equal two feet.

D-4h(5) Outflow Destination. The freeboard control pipe is located between Leachate Ponds A & B; therefore, all leachate will be contained in the redundant pond system. There are no outflow pipes from the stormwater retention impoundment liquid inflow is controlled by manual pumping.

D-4i Dike Stability

D-4i(1) Engineer's Certification. Certification for new dikes will be provided upon completion, as required.

D-4i(2) Dike Design Description. Plans, cross-sections and design details of the dike structures associated with the Leachate Ponds and the Stormwater Retention Impoundment are presented in the Leachate Collection System Drawings; series B511-I.

D-4i(3) Erosion and Piping Protection. All dike slopes are constructed at three horizontal and one vertical (3H:1V). The internal slopes are double-lined and monitored to assess leakage. Dike construction materials are expected to be on-site clays of good compacted strength suitable for piping protection (see Landfill Discussion in Section D-6e(2)(a)).

D-4i(4) Subsurface Soil Conditions. See Sections D-4d(1) and (2).

D-4i(5) Stability Analyses. Stability analyses for a typical dike assuming failure in the double-liner system and development of a phreatic surface are contained in Appendix D-6.3. The analyses indicate adequate safety factors of with the proposed design configurations.

D-i(6) Strength and Compressibility Test Results Unconsolidated. Undrained triaxial tests for compacted on-site soils are presented in Appendix D-6.2. No consolidation tests were performed or were required for analysis.

D-i(7) Dike Construction Procedures. Construction procedures are detailed in the technical specifications and quality assurance manuals for HDPE geomembranes and soil components of liner and capping systems; see Landfill Section D-6 Appendices.

D-i(8) Dike Construction Inspection Program. The quality assurance manual details this program.

## D-5 Incinerators

There are no incineration facilities proposed.

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## D-6 Landfills

As presented on the Proposed Landfill Arrangement Plan, Drawing No. B511E-L3, the proposed design contains two separate landfill facilities (Designated as Landfills I and II). Each landfill will in turn contain three stages of construction and/or operation (designated as Stages I through III). These stages are detailed in Plan and Cross-section in Drawings B511E-L9 through L14, and B511E-L21 through L24 for Landfill I, and in Drawings B511E-L15 through B511E-20 and B511E-L25 through L-28 for Landfill II. These drawings, as well as all others referenced in this section, are found in Appendix A.

Construction of the landfills will begin by grading (excavating) and preparing the base for Landfill I, Stages I and II. Excess borrow materials from this work will be temporarily stockpiled on-site and will be subsequently returned as the landfill area is actively utilized. Landfill construction and operation will also proceed according to a schedule that allows utilization of the empty stages as temporary stormwater holding ponds.

Interim and final landfill slopes will be constructed at 3 horizontal to 1 vertical (3H:1V). Landfill wastes are expected to be both stabilized industrial wastes and direct disposal wastes. It is anticipated that the stabilized wastes will attain significant compressive strength; however, for stability evaluation of the landfill it was assumed that both wastes would act as granular materials and exhibit only strength characteristics from internal friction. Stability analysis of Landfill I in its interim condition when both Stages I and II are complete (worst case with respect to stability) indicate that the proposed slopes and construction staging schemes are adequately stable for both static and earthquake loadings (Refer to Addendum to Geotechnical Evaluation). It is noted that the analysis considers potential failure planes along the HDPE liner and utilizes reduced strength parameters at the liner interfaces.

Bearing capacity and settlement analyses of the landfill foundations are also presented in the Addendum to Geotechnical Evaluation. The clay dike sub-strata is shown to have adequate bearing capacity and is expected to undergo insignificant settlement with respect to the response of the HDPE liner system and drainage.

D-6a List of Wastes Accepted for Landfilling

Wastes previously received for storage are probably not indicative of the future waste mix to be landfilled. It is projected that over the life of the facility one third to one half of the wastes landfilled will be generated as part of CERCLA/Superfund activities. Not enough information is available at this time to characterize this fraction. Therefore, a list of wastes to be landfilled is not available. No free liquids will be disposed of in this landfill.

D-6b Liner System Exemption Requests

No liner system exemption is requested for the proposed landfills at the PROTECO facility in Penuelas, Puerto Rico.

D-6c Liner System, General Items

The following items are discussed as per 40 CFR 270.21 (b)(1), 264.301 (a) and (c).

D-6c(1) Liner System Description. Detailed excavation plans for Landfills I and II are presented on Drawings B511E-L9 and L15, respectively. These plans illustrate the contours for the prepared landfill subgrade (ready for liner system installation). An additional 3-foot depth of excavation and replacement with compacted clay having in-place permeability of $1x10^{-7}$ cm/sec or less, is required. The leachate collection and liner systems for both landfills are detailed on plan Drawings B511E L10 and L-16, and on section drawings B511E L21 through L28.

As indicated the systems are comprised of two distinct designs. One design pertains to the landfill base and the other to the landfill side-slope and interim berms.

The base liner system consists of the following items listed in the order of their occurrence with depth:

1) 12-inches (minimum) of protective cover material

2) A geotextile fabric to separate the protective cover from the primary leachate collection zone

3) 15-inches of granular material with a minimum permeability of $1x10^{-2}$ cm/sec. This unit functions as the primary leachate collection zone and contains a network of 4-inch diameter and 6-inch diameter perforated PVC pipes that terminate at leachate collection manholes, illustrated on Drawing B511E-L28. The manholes will be fitted with automated pumps that will transfer the leachate to the leachate treatment lagoons.

4) An 80-mil (HDPE) primary liner to contain leachate.

5) A second 15-inch thick granular secondary leachate collection zone with an identical pipe system as the primary system. This zone functions as a leakage detection device and is connected to separate stage by stage observation manholes.

6) An 80-mil HDPE secondary liner.

7) Three-feet of compacted clay with a maximum permeability of $1x10^{-7}$ cm/sec.

It is anticipated that the in-situ clay from the proposed grading scheme will be utilized since laboratory testing (Refer to Laboratory Testing within Geotechnical Data of Appendix D-6.1) indicated that the recompacted clay-like sub-strata meet this criteria. In addition, shear strength data from compacted samples indicate that the clay-like size materials possess adequate strength for their proposed use.

The perimeter berm sideslopes and the interim berms are lined with a similar series of elements except that the primary and secondary granular leachate collection and detection zones are replaced by drainage nets.

The components of the liner system are evaluated for design adequacy in the Addendum to Geotechnical Evaluation Appendix D-6.2. As noted in the calculation brief, the daily volume of leachate flow was determined for the condition where an entire landfill cell (Landfill I, Cell 3) was covered with one 8-foot thick life of refuse, having an equivalent permeability of $1 \times 10^{-4}$ cm/sec. The analysis shows that under this extreme condition that the size, perforations, and spacing of the pipe network is adequate when embedded in granular material having a permeability coefficient of $1 \times 10^{-2}$ cm/sec. and that the drainage net has adequate transmissivity to conduct that portion of leachate that enters through the side slopes.

In addition, the drainage net and PVC piping has been selected to accommodate the maximum design loads and construction traffic.

D-6c(2) Liner System Location Relative to High Water Table. Measured groundwater levels under the proposed landfills are shown on the geologic sections of Drawings B511E-L5 through L8. These drawings illustrate that the near surface water table is a minimum of 10 feet below the bases of the proposed landfills. Thus, hydrostatic uplift on the HDPE liners from groundwater is not anticipated.

D-6c(3) Loads on Liner System. Anticipated loads on the liner system will be imposed from construction equipment, landfill equipment, landfilled waste, and settlement. The maximum liner stresses (vertical) will occur at Landfill I, Cell 3 where the maximum height of landfilled material occurs. Imposed loads on the liner at this location will be about 10,000 pounds per square foot (psf). Maximum stress imposed by equipment is expected to occur during placement of primary and secondary drainage material. The construction specification limits the use of equipment to that which will impose ground pressures of 10 pounds per square inch (10 psi).

Lateral stresses in the HDPE liner from construction equipment and landfill settlement are expected to be minimal and at most on the order of 300 pounds per square inches (25 pounds per inch of width).

D-6c(4) Liner System Coverage. Liner system details presented on Drawings B511E-L21 through L24 demonstrate that the liner system will be installed to cover all surrounding earth likely to be in contact with waste or leachate.

D-6c(5) Liner System Exposure Prevention. Protractive cover material is provided in the design details as presented in Drawings B511E-L21 through L24. In addition, when inactive cells are utilized as stormwater holding ponds, the HDPE surface will be covered with a non-woven filter fabric weighted with sand bags. During landfilling operations in completed cells, the sideslope liners will also be covered with filter fabric and ballasted with sand bags.

D-6d Liner System, Foundation

D-6d(1) Foundation Description. A discussion of the regional and site geology as it relates to the hydrologic study is presented in Appendix E.1; however, for implications relative to the geotechnical aspects of the landfill design, a brief summary follows:

The entire PROTECO Project is underlain by the Juana Diaz Formation which at the site is generally comprised of clayey chalk and mudstone units that overlie a hard limestone. Geological cross-sections are presented on Drawings B511E0-L5 through L8 and indicate that the depth to the limestone varies from near zero to 300 feet within the landfill site.

The chalk and mudstone units which will serve as the foundation for the entire landfill are described as unconsolidated (partially lithified) rock deposits which implies that from a geotechnical standpoint that they are soft rock. Exploratory borings (Refer to Boring Logs in Appendix D-6.1), located throughout the site are supportive since the entire units was sampled by standard penetration testing which is typically utilized for sampling soil.

It should be noted, however, that "refusal" for soil sampling procedures is typically defined as a drive hammer blow count in excess of fifty (50) for six inches of sampler penetration. As indicated by the Logs of the Borings performed with soil sampling techniques, hammer blows in excess of 50 per six inches of penetration were common, especially at depths over fifty feet in the clay-like formation. In addition, the average N-valve (standard penetration or hammer blows for 12-inches of sampler penetration) for the near surface samples is indicative of very hard soil or soft rock (Refer to Addendum to Geotechnical Evaluation, Appendix D-6.2).

The above referenced geologic discussion also states that a well-developed soil profile does not occur in the semi-arid environment and in fact, the ridges of the area are soft rock covered by several inches of hard carapache (reprecipitated cover of calcium carbonate).

Thus, in the geotechnical assessment of the proposed development is should be recognized that the sub-strata of primary influence and concern is essentially a soft clay-like rock formation.

D-6d(2) Subsurface Exploration Data. The sub-strata at the site have been characterized by test borings installed in conjunction with numerous groundwater monitoring wells, for existing dike (all to be removed) studies, and for specific site information, Drilling logs for all site borings are presented in Appendix D-6.1. Geologic cross-sections pertinent to the landfill design are presented on Drawings B511E-L5 through L8.

D-6d(3) Laboratory Testing Data. Laboratory test data for site soils pertinent to the foundation evaluation and proposed construction are prepared in Appendix D-6.2. Laboratory tests performed included natural water contents, index properties, grain size distribution, moisture density relationships, unconsolidated-undrained triaxial testing on recompacted samples, and permeability tests of recompacted samples. Strength and compressibility parameters for in-situ materials were inferred from the index properties and soil sampling data (N-values), since representative, undisturbed samples of the hard clay-like rock formation were unattainable.

D-6d(4) Engineering Analyses. Settlement potential, bearing capacity, stability of landfill slopes, and potential for excess hydrostatic or gas pressure are discussed in items (a) through (d) below.

The seismic zone condition as presented in the Addendum to Geotechnical Evaluation, Appendix D-6.2 -- refer to Figure A-3 (Seismic Zone Map of the Contiguous States and Puerto Rico) of the U.S. Army Corps of Engineers Manual, ER-1110-2-1806, 16 May 1983 --places the site in Zone 3 (Major Drainage Zone) and the referenced manual recommends a seismic coefficient for embankment design of 0.15 g.

Geologic study, well installation data and other miscellaneous borings indicate no significant voids in the underlying limestone strata. No mining of any mineral deposits are performed within the site or within influence of the site. Therefore, the potential for subsidence and sinkhole development appears non-existant.

D-6d(4)(a) Settlement Potential. Settlement potential for the two landfill structures, based on recompression of the variable thickness of highly over-consolidated clay-like sub-strata are presented in the Addendum to Geotechnical Evaluation, Appendix D-6.2. The analysis indicates that maximum and differential settlements of about 17 and 14 inches, respectively, are anticipated at Landfill II. The strains and corresponding liner stresses due to the differential settlements are shown to be negligible.

D-6(4)(b) Bearing Capacity. Bearing capacity analyses are presented in the Addendum to Geotechnical Evaluation, Appendix D-6.2. The analysis indicates that for the maximum loading condition at Landfill I (about 10 feet of landfilled material) the foundation sub-strata of clay-like rock has adequate strength.

D-6(4)(c) Stability of Landfill Slopes. Stability analyses for the following conditions are presented in the Addendum to Geotechnical Evaluation, Appendix D-6.2:

- Permanent cut slopes for access road construction (static and earthquake loading).

- Typical interim dike construction.

- Worst case landfill operations condition with reduced parameters at HDPE to soil interfaces (static and earthquake).

- Typical pond dike assuming ruptured or ineffective liner.

The analyses demonstrate acceptable factors of safety.

D-6d(4)(d) Potential for Excess Hydrostatic or Gas Pressure. Measured groundwater levels under the proposed landfills are shown on the geologic sections of Drawings B511E-L5 through L8 and indicate that the near surface water level is a minimum of 10 feet below the proposed landfill bases. Thus, hydrostatic uplift on the HDPE liners from site groundwater conditions is not anticipated.

The potential for gas pressure under the liner system is also negligible as all organics will be removed from the foundation of the landfill areas and there are no known existing or abandoned oil and/or gas wells within the facility.

D-6e Liner System, Liners

D-6e(1) Synthetic Liners. The design includes two synthetic liners having the same dimensions and properties as follows:

- Thickness: 80 mil

- Type/Material: High Density Polyethylene (HDPE)

- Brand Name/Manufacturer -- To be determined pending liner compatibility testing -- tentatively: Gundle

D-6e(1)(a) Synthetic Liner Compatibility Data. Further data to be provided upon completion of study.

D-6e(1)(b) Synthetic Liner Strength. The strength and material properties of the HDPE membrane tentatively chosen for the PROTECO facility is given in Table 1 of the Quality Assurance Manual for the Installation of HDPE Geomembranes for Proteccion Tecnica Ecologica, Inc. (Appendix D.6.3)

D-6e(1)(c) Synthetic Liner Bedding. Liner details on Drawings B511-L21 through L28 show that the base system will have 15 inches of free draining granular material on either side of the primary liner and atop the secondary liner. The secondary liner is placed on a three-foot thick compacted clay base. Calculations contained in the Addendum to Geotechnical Evaluation, Appendix D-6.2 indicate that minimal stresses will be induced in the synthetic liners during placement of the granular drainage material.

D-6e(2) <u>Soil Liners</u>. A three-foot thick compacted clay liner will provide a uniform foundation for the secondary synthetic membrane throughout both landfills. The clay is to be excavated and recompacted in-situ material forming the base for the proposed grading schemes.

Permeability tests on recompacted typical, clay-like site soils as presented in Appendix D-6.2 indicate that permeabilities less than $1 \times 10^{-7}$ cm/sec are attainable at near optimum compaction.

D-6e(2)(a) Material Testing Data. Laboratory test data for typical site soils are presented in Appendix D-6.2 and indicate that the site soils are predominantly clays of high plasticity (CH). On-site conditions demonstrate that the dispersion of these soils is unlikely.

It is anticipated that the soil liner (and dikes) will be concentrated on highly impervious, plastic site soils in accordance to the Quality Assurance Plan for Installation of the Soil Component of Liner and Final Cover Systems. Published data (refer to Table 9-2, "Resistance of Earth Dam Embankment Materials to Piping and Cracking" presented with dike stability calculations in Appendix D-6.2) indicate that soils of the CH type have the greatest resistance to piping. Therefore, piping is also considered unlikely.

D-6e(2)(b) Soil Liner Compatibility Data. Data to be provided upon completion of study.

D-6e(2)(c) Soil Liner Thickness. Landfill units will have a double synthetic liner system, thus the described analysis is not required.

D-6e(2)(d) Soil Liner Strength. Strength data from compacted site soil samples are included in the Addendum to Geotechnical Evaluation, Appendix D-6.2, and indicate that the compacted soil has adequate strength.

D-6f <u>Liner System, Leachate Collection/Detection System</u>

D-6f(1) <u>System Operation and Design</u>. The system operation and design is described in detail in Section D-6c(1).

D-6f(2) <u>Equivalent Capacity</u>. Calculations demonstrating the equivalent capacity requirements are contained within the leachate system evaluation of the the Addendum to Geotechnical Evaluation, Appendix D-6.2.

D-6f(3) <u>Grading and Drainage</u>. A detailed grading plan of the leachate collection/detection system are presented of Drawings B511E-L10 through L16 for Landfills I and II, respectively.

D-6f(4) <u>Maximum Leachate Head</u>. The calculations for the expected maximum leachate head are included in the Addendum to Geotechnical Calculations, Appendix D-6.2 and demonstrate that the depth of flow (head) is less than one foot.

D-6f(5) System Compatibility. Data to be provided upon completion of study.

D-6f(6) System Strength.

D-6f(6)(a) Stability of Drainage Layers. Bearing capacity and stability calculations which consider the strength of the drainage layer material are included in the Addendum to Geotechnical Evaluation, Appendix D-6.3. All sloped surfaces will be covered with geosynthetics and geonets which will be keyed into the tops of the slopes to provide stability.

D-6f(6)(b) Strength of Piping. Calculations included in the Addendum to Geotechnical Evaluation show that the piping is adequate under stresses from construction equipment and landfilling conditions.

D-6f(7) Prevention of Clogging. The landfill design documents (see Appendix A) include standard design details to prevent the clogging of the 15" primary leachate collection zone. Non-woven geotextile is called for between the protective cover and this zone. HART's standard detail for the underdrains themselves is shown on Drawing B511E-L22. Clogging is minimized by large cross-section of the underdrain in combination with direct underdrain contact with the waste. In this design, if the primary zone itself clogs (which can happen because the filter cloth filters the leachate and blinds), the underdrains can drain the waste directly. The design features which assure extended long-term operation of the landfill's primary leachate collection system are:

- doweling of all joints to prevent separation of pipes due to settling.
- cleanouts of all major collection interceptors.
- cap-as-you-go landfilling, which minimizes the volume of leachate that will pass through the system (this limits overall clogging potential).

The secondary leachate collection system is designed to prevent clogging through surrounding of the underdrain with nonwoven geotextile fabric.

D-6(g) Liner System, Construction and Maintenance

D-6g(1) Material Specifications [D6g(1)(a) through (1)(c)]. These specifications are presented in the Specifications Documents Appendix D-6.4.

D-6g(2) Construction Specifications [D-6g(2)(a) through (2)(d)]. These are presented in Specifications Documents Appendix D-6.4.

D-6g(3) Construction Quality Control Program. These are presented in Construction Specifications Appendix D-6.4.

D-6g(4) Maintenance Procedures for Leachate Collection/Detection Systems. These are presented in Construction Specifications Appendix D-6.4.

D-6g(5) Liner Repairs During Operations. These are presented in Construction Specifications Appendix D-6.4.

D-6h Run-on and Run-off Control Systems

D-6h(1) Run-on Control System. A run-on control system has been designed to prevent stormwater flow onto the active portions of Proposed Landfills I and II and other hazardous waste units. The system consists of a network of permanent stormwater diversion channels located around the perimeter of the site.

D-6h(1)(a) Design and Performance. The run-on control system was designed to intercept overland flow from the upland areas surrounding the site. The channel network diverts this water from all active portions of the landfills and other units to a safe discharge point at the downstream end of the site. All channels are sized to carry peak discharge from the 25 year, 24 hour storm and are adequately protected for erosion and sediment control. This plan will be implemented during the first phase of construction, prior to waste placement in either Landfill I or II and will remain intact for the life of the facility. For a detailed plan view of this channel network, see Drawing B511E-L11. Channel invert elevations are shown on Drawing B511E-L20. Channel details and construction information are supplied on Drawing B511E-L29. Run-on volumes, channel design and channel protection calculations can be found in Appendix D-6.5.

In addition to the overall run-on control system, ancillary construction procedures will be implemented to prevent run-on from the active portions of the landfill during intermediate stages of development. During Stage 1 development, when waste is placed in Stage 1 and the Stage 2 area is being used for temporary stormwater retention, water entering the Stage 3 area will be prevented from reaching the active portions by a temporary diversion dike. The 3 foot high (minimum) dike will be constructed of compacted clay, in the direction parallel to the interim berm. The dike will be located approximately 10 feet from the top of the cut slope that extends from the existing ground surface down to the bottom of the landfill outside the interim berm. Uncontaminated water ponded between the interim berm and the temporary diversion dike will be removed by pumping and discharged to the sedimentation basin. Water collected in the Stage 3 area will be removed through a temporary culvert. For a plan view see Drawing B511E-L11 and L17. For culvert profiles and construction information see Drawing B511E-L31. Design calculation are included in Appendix D-6.5.

D-6h(1)(b) Calculation of Peak Flow. Peak surface water flow resulting from the 25 year, 24 hour design storm was calculated using the USDA Soil Conservation Service Technical Release No. 55. The entire contributory watershed area was divided into several sub-areas. Peak run-on discharges was calculated and a unit hydrograph was developed for each sub-area. The factors affecting peak discharge calculations are the 24-hour rainfall amount, rainfall distribution, hydrologic soil-cover complexes, time of concentration, travel time and drainage area. All calculations, data and data sources are shown in Appendix D-6.5.

D-6h(2) Run-off Control System. A run-off control system has been designed to collect and control run-off from the active portions of the landfill. The system includes provisions for all stages and substages of landfill development. A series of perimeter channels, bench diversion channels, fluted inlets, drop inlets, culverts and silt fences have been designed to provide permanent erosion and run-off control for the final site configuration. In addition, a number of temporary channels, retention cells, and a sedimentation basin will be used in the interim stages of landfill development to control run-off from the active portion of the site.

D-6h(2)(a) Design and Performance. The completed secure landfills are designed to shed water. The contours of the final cap slope downward from the center towards the perimeter berms. Benches with channels will be built into the 3:1 slopes approximately every 30 vertical feet to intercept the uncontaminated run-off and minimize erosion. Runoff will be transported off the benches by a system of fluted and drop inlets with outlet pipes to the permanent stormwater diversion channels which will convey the water to a safe outlet at the downstream end of the site. In addition, channels will be located on the perimeter berms to collect run-off from the lower portions of the 3:1 slopes. Culverts and concrete lined channel crossings have been designed to safely divert water from access roads. Adequate channel and outlet protection has been incorporated in the design for erosion control. For a plan view of the run-off control system see Drawing B511E-L20. Details and construction for all channels, inlets, and culverts are shown on Drawing B511E-L29 through L-31. All design calculations are included in Appendix D-6.5.

Until permanent vegetation can be established on the final cap, silt fences will be constructed around all channels collecting run-off from those areas. The silt fences will be installed immediately after construction of the final cap and will be maintained in good operating condition until stabilization of upstream contributing areas is achieved. Silt fences will be anchored and constructed in accordance with the "Technical

Specifications, Proposed Hazardous Waste Landfill and Surface water Management Facilities," dated January 31, 1986. The filtering medium for the silt fences is also specified in that document.

The proposed landfill liner systems and subsequent waste placement will advance by stages separated by interim berms, as shown on Drawings B511E-L11 through L20. This staged construction/waste placement procedure will provide temporary stormwater retention cells for run-off from the uncapped portions of the landfill. A total of two cells will be used for each landfill. One cell will be used when Stage 1 is constructed, the other cell will be used during Stage 2 construction. Substaging is required to control run-off during Stage 3 construction and will also be discussed.

As the landfill liner system of Stage 1 is constructed, the compacted clay sub-base, secondary liner, secondary leachate collection system and the primary liner on the floor of the landfill will also be constructed for Stage 2. In addition, a layer of non-woven geotextile fabric will be placed on top of the primary liner for protection. The geotextile and liner will extend up the sideslopes of the landfill to the limits shown on Drawing Nos. B511E-L1, L12, L17 and L18. This configuration will form the base and two sides of the temporary retention cells. Two interim berms will be constructed to separate the three stages of the landfill. The berms will be constructed of compacted clay (permeability less than or equal to $10^{-7}$ cm/sec), with an eight foot minimum top width perpendicular to the sideslopes of the landfill to form the other two sides of the retention cell. The secondary liner, secondary leachate collection system and the primary liner will be extended over the first interim berm and across the floor of the Stage 2 area to the second interim berm. The secondary liner will extend over the second interim berm. The secondary leachate collection system and primary liner will terminate on top of the second interim berm. A piece of 40 mil HDPE geomembrane will be welded to both the primary and secondary liners on top of the second interim berm to segregate the secondary leachate collection systems between stages. The limits of the geotextile and liner on the sideslopes and the heights of the interim berms were designed to provide sufficient capacity to contain the run-off from the Stage 1 landfill development as well as direct rain- fall into the basin. Sufficient freeboard has also been provided. Design calculations may be found in Appendix D-6.5.

Run-off from the active portions of the landfill in Stage 1 will be diverted into the temporary stormwater retention cells be temporary stormwater diversion channels. The channels are located around the perimeter of the landfills, below the elevation of the perimeter berm. The 3:1 sideslopes of compacted refuse extending up from the perimeter berm to the top of the landfill will form one side of the channel. The 3:1 sideslopes of the landfill extending down from the perimeter berm to the landfill floor will form the other side of the V-shaped channel. They will have a minimum depth of 3 feet and grade to drain into the retention cells. The channels will be lined with 40 mil HDPE geomembrane in order to reduce surface water infiltration into the primary leachate collection system. The 40 mil HDPE geomembrane will be welded to the 80 mil HDPE primary liner on the perimeter berm and keyed into the compacted refuse (12-inch minimum embedment). After each rainfall event, ponded water in the retention cells will be tested for contamination. If uncontaminated, the water will be pumped into the Sedimentation Basin (a NPDES permit will be applied for this basin). If the water is contaminated it will be pumped into the Leachate Pond for treatment.

At the completion of operations in Stage 1, the landfill liner system in Stage 2 will be extended up the sideslopes. The temporary stormwater retention cell will then be constructed as previously described in Stage 3 to collect run-off from Stage 2 landfill development. For plan views of the stages of site development and run-off control see Drawings B511E-L11, L12, L17, and L18. Cross sections and details are shown on Drawings B511E-L21, L22, L25, and L26.

In addition to the staged sequence of landfill development previously described, a substaging procedure has also been developed to minimize rainwater to leachate in the primary collection system (for various reasons). This substaging will also be used to control run-off from the active portions of the landfill in Stage 3 area of development. Drawing B511E-L33 shows details, cross-sections, an isometric view, and provides an operations narrative for the substaging procedures. A portion of the run-off in the substages will percolate down through the waste daily cover and into the waste and be collected in the primary leachate collection system. The remaining portion of the rainfall will run down the perimeter sideslopes and waste daily cover and drain across the protective cover. This run-off will flow by gravity to the low point of the unused liner system, near the collection system riser, which has been covered with a 30' by 30' piece of geotextile fabric. Run-on water collected here will be tested for contamination prior to removal. If uncontaminated, the water will be pumped to the Sedimentation Basin. If contaminated, the water will be pumped to the leachate ponds for treatment.

As placement of the waste in the final substage of Stage 3 nears completion, additional provisions must be made to control run-off from the active portions of the landfill. During this time, landfill activity will be restricted to dry weather. Final capping will proceed as quickly as possible so as to prevent the flow of surface water on uncapped portions thereby limiting infiltration.

A Sedimentation Basin has been designed as a holding facility for a portion of the surface water runoff. The Sedimentation Basin will only be used during the construction phase of the landfills. The basin will be used to contain runoff pumped from the temporary stormwater retention cells and will not collect any direct runoff. Runoff from other areas will be controlled with channels and silt fences. The basin is sized for the maximum runoff conditions when the Stage 3 area is the retention cell for Stages 1 and 2. Run-off collected in this area will generally be pumped out in a 24-hour period.

The basin was designed in accordance with the standards and specifications of the U.S.D.A. Soil Conservation Service of the Caribbean Area. The basin incorporates on 18-inch diameter corrugated metal riser pipe as a principal spillway. The principal spillway discharges into one of the the permanent stormwater diversion channels that is part of the overall run-on/run-off system.

The basin will be maintained as discussed in Section D-6h(3). For the Sedimentation Basin plan, profiles and details see Drawing B511E-L32. Design calculations are included in Appendix D-6.5.

D-6h(2)(b) Calculation of Peak Flow. The total run-off volume expected to result from the 25-year, 24-hour storm for both Landfill I and Landfill II is 13.0 acre-feet.

The data sources and methods used are as described in Section D-6h (1)(b). Design calculations and data are included in Appendix D-6.4.

D-6h(3) <u>Management of Collection and Holding Units</u>. Two types of collection and holding facilities will be used as part of the overall run-on/run-off control system: the sedimentation pond and temporary stormwater retention cells. As described in Section D-6h(2)(a), the temporary stormwater retention cells will be used to collect run-off from the active portions of the landfill during the staged sequence of landfill development. After each storm event, ponded water in the cells will be tested for contamination. If uncontaminated, water will be pumped out, generally within a 24-hour period, into the sedimentation pond. If contaminated, it will be pumped into the leachate ponds for treatment.

The sedimentation pond will be used as described in Section D-6h (2)(a). In order to maintain adequate sediment storage capacity, the basin will be cleaned out on a regular basis. The maximum allowable sediment level (calculations shown in Appendix D-6.5) will be clearly marked on the riser. Sediment removed from the basin will be placed in designated areas (see Appendix D-6.5) and graded so as surface water flow to the permanent stormwater diversion channels will not be impeded. These areas will be vegetated using the materials and methods documented in Appendix D-6.4 in the "Technical Specifications, Proposed Hazardous Waste Landfill and Surface water Management Facilities," dated January 31, 1986. Until permanent vegetation can be established, silt fences will be constructed as a temporary sedimentation control measure using the methods and materials outlined in the document cited above.

D-6h(4) Construction. The run-on and run-off control system will be constructed according to the methods and materials presented in Appendix D-6.4 in the "Technical Specifications, Proposed Hazardous Waste Landfill and Surface Water Management Facilities," dated January 31, 1986.

D-6h(5) Maintenance. The run-on and run-off control systems will be maintained according to Appendix D-6.4 in the "Technical Specifications, Proposed Hazardous Waste Landfill and Surface water Management Facilities," dated January 31, 1986. Inspections of these systems will be conducted regularly as described in Section F-2. Any signs of clogging or system failure will be noted and corrected.

APPENDIX D-6.1

LANDFILL AND

SURFACE WATER MANAGEMENT FACILITIES

GEOTECHNICAL DATA

This material was previously submitted.

APPENDIX D-6.2

LANDFILL AND

SURFACE WATER MANAGEMENT FACILITIES

ADDENDUM TO GEOTECHNICAL EVALUATION

(0641B-8)

TABLE OR CONTENTS

ITEM 1

BEARING CAPACITY ANALYSIS

LANDFILLS I & II

(0655B-2)

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SUBJECT PROTECO - GEOTECHNICAL EVALUATION JOB NO. B-511E
BEARING CAPACITY / SETTLEMENT / STABILITY EVALUATION
GENERAL DISCUSSION

THE PROTECO LANDFILLS (I & II) ARE UNDERLAIN BY THE JUANA DIAZ FORMATION WHICH HAS BEEN IDENTIFIED BY THE U.S.G.S. AS AN UNCONSOLIDATED, PARTIALLY LITHIFIED ROCK DEPOSIT. ON-SITE ASSESSMENT & BOREHOLE DATA CONFIRM THAT THE CLAY-LIKE SUBSTRATA ARE ESSENTIALLY SOFT CLAYSTONE. FROM A SOIL MECHANICS STANDPOINT, THIS SUBSTRATA IS CLASSIFIED AS A HARD SILTY CLAY THAT IS OVER-CONSOLIDATED WITH RESPECT TO COMPRESSION CHARACTERISTICS.

STRENGTH DATA IS INFERRED FROM LABORATORY TESTING ON RE-COMPACTED SITE SOIL AND EXISTING DIKE FILL, FIELD PENETROMETER DATA, STANDARD PENETRATION TESTING, AND FIELD OBSERVATIONS.

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SUBJECT PROTECO – GEOTECHNICAL EVALUATION JOB NO. B-511E
BEARING CAPACITY ANALYSIS – REVISED LANDFILLS I & II

## PROBLEM STATEMENT

DEMONSTRATE THAT THE REVISED LANDFILL AREAS (I & II) HAVE ADEQUATE BEARING CAPACITY TO SUPPORT THE PROPOSED LANDFILL LOADINGS.

## STRENGTH DATA

A) LABORATORY TESTS {3 UNCONSOLIDATED, UNDRAINED TESTS}

1) $\phi_u = 3.2$ $C_u = 1150$ PSF (SAMPLE RE-COMPACTED TO MODIFIED PROCTOR DENSITY)

2) $\phi_u = 8.4°$ $C = 1020$ PSF {LANDFILL DIKE BORING IF-2A DEPTH SAMPLE 2.5→5'}

3) $\phi_u = 20°$ $C = 320$ PSF {LANDFILL DIKE BORING OL-2 DEPTH 8→10.5'}

B) FIELD PENETROMETER DATA

DATA PRESENTED ON LOGS FOR BORINGS I.M. 2-1, I.M. 1-1, I.M. 1-C

$Q_u$ (AVG) FOR 19 TESTS = 3.9 TSF {SEE SHEET 2}

C) STANDARD PENETRATION TESTS (N-VALUE)

REPRESENTATIVE DATA ON BORINGS TB-1, TB-2, 11W-83, 12W-83

1) TB-1 (0→72' DEPTH) $N_{AVG} = 45$

2) TB-2 (0→45' DEPTH) $N_{AVG} = 28$
$D_P > 45'$ $N > 100$

3) 11W-83 (0→65' DEPTH) $N_{AVG} = 40$
$D_P > 65'$ $N > 100$

4) 12W-83 (0–55' DEPTH) $N_{AVG} = 51$
$D_P > 55$ $N > 100$

SEE SHEET (4)

RANGE OF N IS ≈ 25 → 50 AVG N ≈ 40 (INCREASES WITH DEPTH)

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SUBJECT: PROTECO - GEOTECHNICAL EVALUATION JOB NO. B-511E
BEARING CAPACITY ANALYSIS - REVISED LANDFILL

DETERMINE AVERAGE UNCONFINED COMPRESSIVE STRENGTHS OF CLAY SOILS AT BORINGS I.M.2-1, I.M.1-1, AND I.M 1-C (SEE APPENDICES: VOLUME III FOR RCRA PART B PERMIT APPLICATION)

BORING IM 2-1 (DEPTH 62.5') WL@36'

$$\sum_1^7 Q_u = 4.5 + 3.9 + 5.4 + 5.1 + 3.8 + 4.8 + 3.8$$
$$= 31.3 \text{ TSF}$$
$$Q_u \text{ (AVG)} = 4.5 \text{ TSF}$$

BORING I.M. 1-1 (DEPTH = 66') WL@54'

$$\sum_1^5 Q_u = 4.3 + 3.9 + 3.3 + 2.0 + 3.7 = 17.2$$
$$Q_u \text{ (AVG)} = 3.4 \text{ TSF}$$

BORING I.M. 1-C (DEPTH 65') WL>65'

$$\sum_1^7 Q_u = 2.8 + 3.3 + 3.8 + 4.7 + 3.9 + 4.7 + 2.3$$
$$= 26.0$$
$$Q_u \text{ (AVG)} = 3.7 \text{ TSF}$$

AVG. ALL DATA:

$$\sum_1^{19} Q_u = 74.5 \qquad Q_u \text{ (AVG)} = 3.9 \text{ TSF}$$

SUBJECT PROTECO - GEOTECHNICAL EVALUATION JOB NO. B-511E
BEARING CAPACITY ANALYSIS - REVISED LANDFILLS I & II

C) STANDARD PENETRATION TESTS (CONT'D)

FROM "BASIC SOIL ENGINEERING" P. 297, B.K. HOUGH (FIRST ED.)
FOR HARD SANDY OR SILTY CLAY N = 40, THE MAXIMUM ADVISABLE PRESUMPTIVE BEARING CAPACITY RANGE IS $4 \rightarrow 5^+$ TSF. NOTE THAT IF N-VALUES THAT EXCEEDED 100 WERE USED IN AVERAGING N, RANGE COULD APPROACH $5 \rightarrow 7$ TSF WITH DEPTH (LIMIT OF FIG. 10-13)

D) VISUAL ASSESSMENT VIA NAVFAC DM-7 (1971) TABLE 11-1.

a) FOR HARD SILTY CLAY, RANGE OF ALLOWABLE BEARING CAPACITY IS $3 \rightarrow 6$ TSF

b) FOR SOFT ARGILLACEOUS ROCK, RANGE IS $8 \rightarrow 12$ TSF

CONCLUSION: A PRESUMPTIVE BEARING CAPACITY OF 6 TSF APPEARS REASONABLE FOR THE CLAY-LIKE SUBSTRATA.

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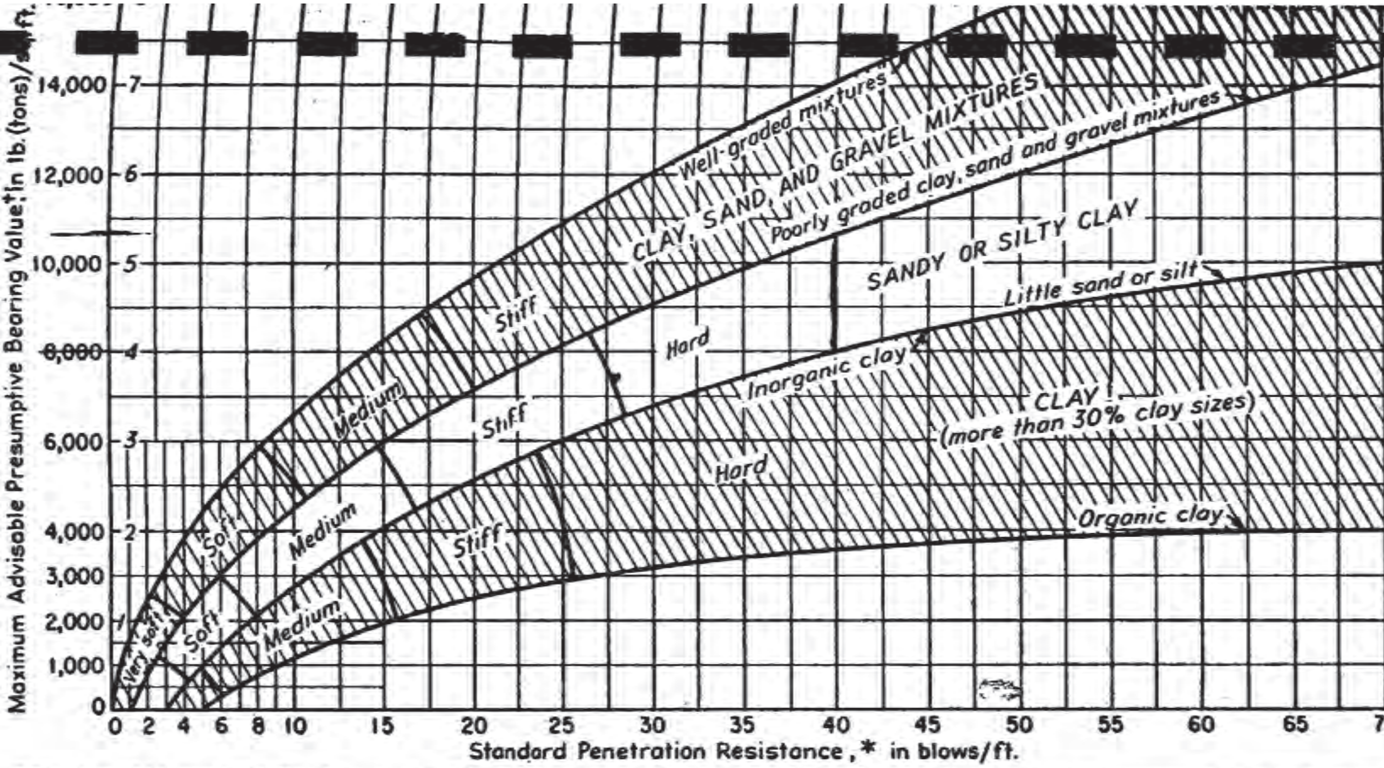


* Number of blows of 140-lb. pin-guided weight falling 30 in. per blow required to drive a split-barrel sample spoon with a 2-in. outside diameter 12 in.

† Higher values may be used for precompressed (or compacted) clays of low sensitivity than for normally loaded or extra-sensitive clays.

FIG. 10–13. Presumptive bearing values, clays and mixed soils.

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**TABLE 11-1**

**Nominal Values of Allowable Bearing Pressures for Spread Foundations**

| Type of bearing material | Consistency in place | Allowable bearing pressure tons per sq ft: Ordinary range | Allowable bearing pressure tons per sq ft: Recommended value for use |
|---|---|---|---|
| Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks). | Hard, sound rock | 60 to 100 | 80 |
| Foliated metamorphic rock: slate, schist (sound condition allows minor cracks). | Medium hard sound rock | 30 to 40 | 35 |
| Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities. | Medium hard sound rock | 15 to 25 | 20 |
| Weathered or broken bed rock of any kind except highly argillaceous rock (shale). | Soft rock | 8 to 12 | 10 |
| Compaction shale or other highly argillaceous rock in sound condition..... | Soft rock | 8 to 12 | 10 |
| Well graded mixture of fine and coarse grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC). | Very compact | 8 to 12 | 10 |
| Gravel, gravel-sand mixtures, boulder-gravel mixtures (GW, GP, SW, SP) ... | Very compact | 7 to 10 | 8 |
| | Medium to compact | 5 to 7 | 6 |
| | Loose | 3 to 6 | 4 |
| Coarse to medium sand, sand with little gravel (SW, SP) .................. | Very compact | 4 to 6 | 4 |
| | Medium to compact | 3 to 4 | 3 |
| | Loose | 2 to 3 | 2 |
| Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC).. | Very compact | 3 to 5 | 3 |
| | Medium to compact | 2 to 4 | 2.5 |
| | Loose | 1 to 2 | 1.5 |
| Fine sand, silty or clayey medium to fine sand (SP, SM, SC).............. | Very compact | 3 to 4 | 3 |
| | Medium to compact | 2 to 3 | 2 |
| | Loose | 1 to 2 | 1.5 |
| Homogeneous inorganic clay, sandy or silty clay (CL, CH)................ | Very stiff to hard | 3 to 6 | 4 |
| | Medium to stiff | 1 to 3 | 2 |
| | Soft | .5 to 1 | .5 |
| Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH) ... | Very stiff to hard | 2 to 4 | 3 |
| | Medium to stiff | 1 to 3 | 1.5 |
| | Soft | .5 to 1 | .5 |

Notes:

1. Variations of allowable bearing pressure for size, depth and arrangement of footings are given in Table 11-2.
2. Compacted fill, placed with control of moisture, density, and lift thickness, has allowable bearing pressure of equivalent natural soil.
3. Allowable bearing pressure on compressible fine grained soils is generally limited by considerations of overall settlement of structure, Table 6-1.
4. Allowable bearing pressure on organic soils or uncompacted fills is determined by investigation of individual case.

compressibility of subsoils is constant with depth, analyze consolidation settlement of the entire foundation.

**5. PROPORTIONING INDIVIDUAL FOOTINGS.** Where significant compression will not occur in strata below a depth equal to the distance between footings, proportion size of individual footings to give equal settlement; use formulas for immediate settlement in Figures 11-8 and 11-9. Where significant consolidation settlements may occur below this depth, select footing size on the basis of the safety factor against ultimate failure as a first trial. Analyze overall consolidation settlements for the combined effect of these individual footings. In this case, settlements are controlled by the combined stresses of all foundation units and may be little affected by alteration of individual footing areas.

 Bowles, E.

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Correlation between unconfined compressive strength and penetration number of cohesive coils has also been published, as in Table 3-3. The indicated values of unconfined compressive strength correlated to penetration number in Table 3-3 should be used cautiously, however. Experiences in different areas indicate that it is not unusual to get penetration numbers of 6 to 10 on soils where the unconfined compressive strength may be from 6 to 12 ksf, which is considerably different from data shown in the table, where $q_u$ is approximately one-fourth of the penetration number. A valid correlation between the penetration number and the shear strength

**Table 3-3 Empirical values for $q_u$† and consistency of cohesive soils based on the standard penetration number**

| Consistency | | Very soft | | Soft | | Medium | | Stiff | | Very stiff | | Hard |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $q_u$, ksf | 0 | | 0.5 | | 1.0 | | 2.0 | | 4.0 | | 8.0 | |
| $N$, standard penetration resistance | 0 | | 2 | | 4 | | 8 | | 16 | | 32 | |
| $\gamma_{(sat)}$, pcf | | | 100–120 | | | 110–130 | | | 120–140 | | | |

† These values should be used as a guide only. Local cohesive samples should be tested, and the relationship between $N$ and the unconfined compressive strength $q_u$ established as $q_u = KN$.

of cohesive ($\phi$-$c$) soils can be made only on a local basis, and then the validity may be suspect, unless large enough quantities of tests are made to allow a statistical analysis.

In general, to correlate penetration number to the shear strength of a cohesive ($\phi$-$c$) soil involves evaluating the following expression for the constant of proportionality:

$$q_u = KN \tag{3-4}$$

where $K$ = proportionality constant
$N$ = penetration number

The penetration test applied to gravel or gravelly soils and silty sands yields results which require careful interpretation. In loose gravel the voids formed when the gravel is displaced by the driving shoe of the split spoon may yield low penetration numbers. On the other hand, if the spoon pushes a large piece of rock, the number may be too high.

In silty sands, Meyerhof [9] suggests that the bearing capacity be reduced 50 percent [using Eqs. (2-20) and (2-21)]. For gravel the bearing capacity computed by these methods should be increased by a factor of 2.0. Terzaghi and Peck [10] have recommended that if the soil is a very fine, or silty, saturated sand and if the measured penetration number $N$ is greater than 15, an adjusted design value of $N'$ be used, as

$$N' = 15 + \tfrac{1}{2}(N - 15) \tag{3-5}$$

This was based on the assumption that the critical void ratio occurs at approximately

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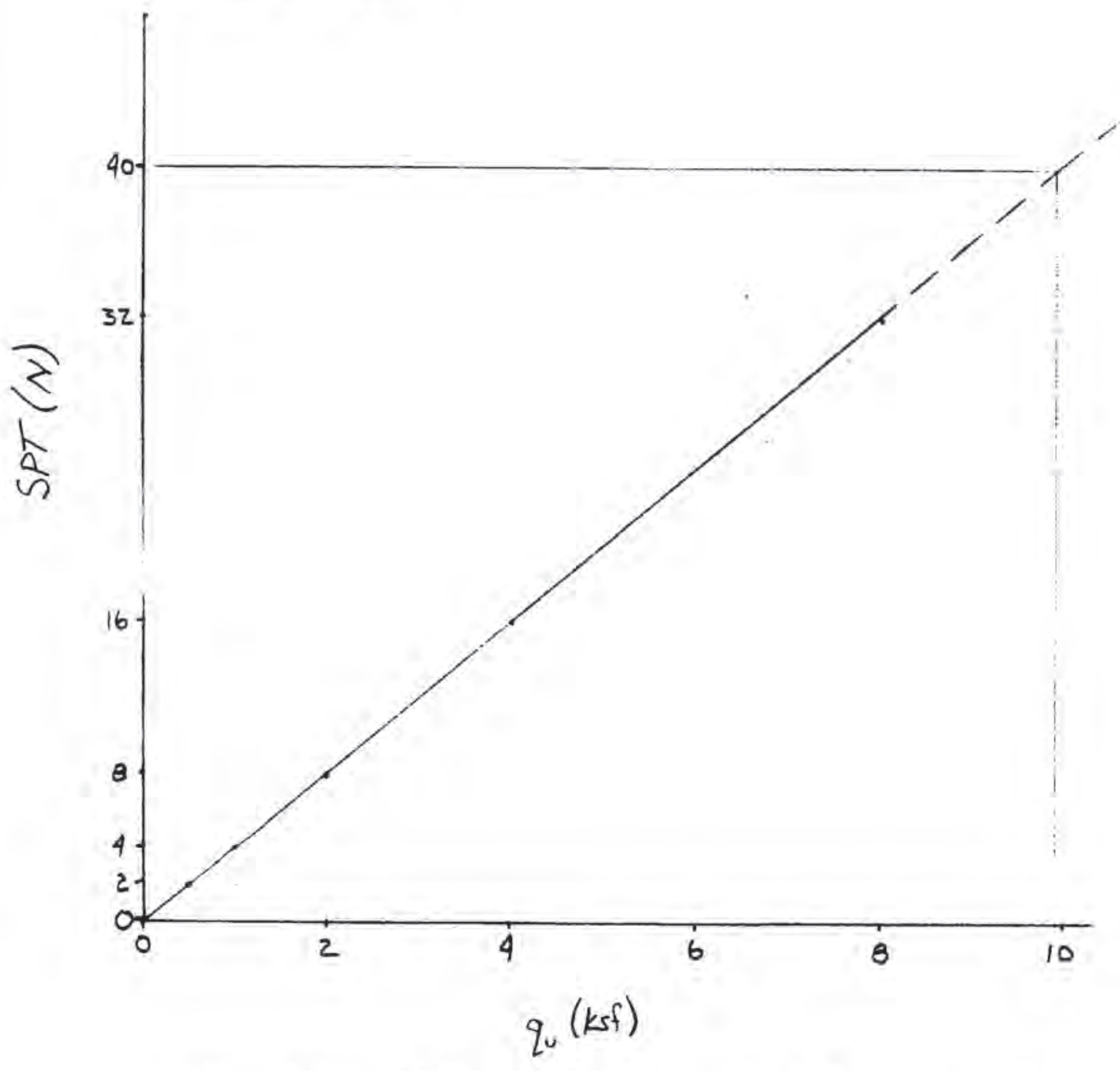
SUBJECT PROTECO - GEOTECHNICAL EVALUATION JOB NO. B-511E
BEARING CAPACITY ANALYSIS - REVISED LANDFILLS 1 & 2

E) plotting attached data from Table 3.3 Bowles Foundation Analysis and Design p.126




extrapolation of the curve shows that for $N_{avg} \sim 40$ an ult. bearing capacity of approx. 10 ksf or 5 tsf

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SUBJECT PROTECO – GEOTECHNICAL EVALUATION JOB NO. R[illegible]

BEARING CAPACITY ANALYSIS – REVISED LANDFILL

DETERMINE AVERAGE N-VALUES FOR BORINGS TB-1, TB-2, 11W-83, 12W-83 AS PER SHEET 3

ⓐ TB-1

$$\sum_{1}^{17} N = 11 + 14 + 18 + 35 + 29 + 25 + 13 + 21 + 44 + 46 + 43 + 50 + 74 + 79 + 96 + 90 + 82 = 770$$

$$\text{Avg N} = 770/17 = 45$$

ⓑ TB-2

$$\sum_{1}^{12} N = 8 + 11 + 16 + 16 + 19 + 24 + 23 + 28 + 41 + 45 + 38 + 61 = 330$$

$$\text{Avg N} = 330/12 = 28$$

ⓒ 11W-83

$$\sum N_1^7 = 26 + 32 + 30 + 42 + 39 + 52 + 57 = 278$$

$$\text{Avg N} = 278/7 = 40$$

ⓓ 12W-83

$$\sum N_1^5 = 58 + 60 + 45 + 36 + 55 = 254$$

$$\text{Avg N} = 254/5 = 51$$

RANGE AVG 'N' SAY 25 → 50

AVG. 'N' IS $1632/41 \approx 40$

SUMMARY OF STRENGTH EVALUATION / PARAMETERS

1) SUBSTRATA IS ROCK (CLAYSTONE) THAT INCREASES IN STRENGTH WITH DEPTH

2) BASED ON PENETROMETER READINGS, AVERAGE N-VALUES AND VISUAL ASSESSMENT, A PRESUMPTIVE BEARING VALUE OF 6 TSF APPEARS REASONABLE.

3) THE FOUNDATION ADEQUACY CAN BE MORE READILY ASSESSED AS A SLOPE STABILITY PROBLEM EXTENDING THROUGH THE LANDFILL MATERIAL AND INTO THE UNDERLYING SUBSTRATA.

ASSESS BEARING CAPACITY FOR VARIOUS STAGES OF LANDFILL CONSTRUCTION

REFERENCE DRAWINGS:

LANDFILL I : B511E-L19, L13, L23, L10

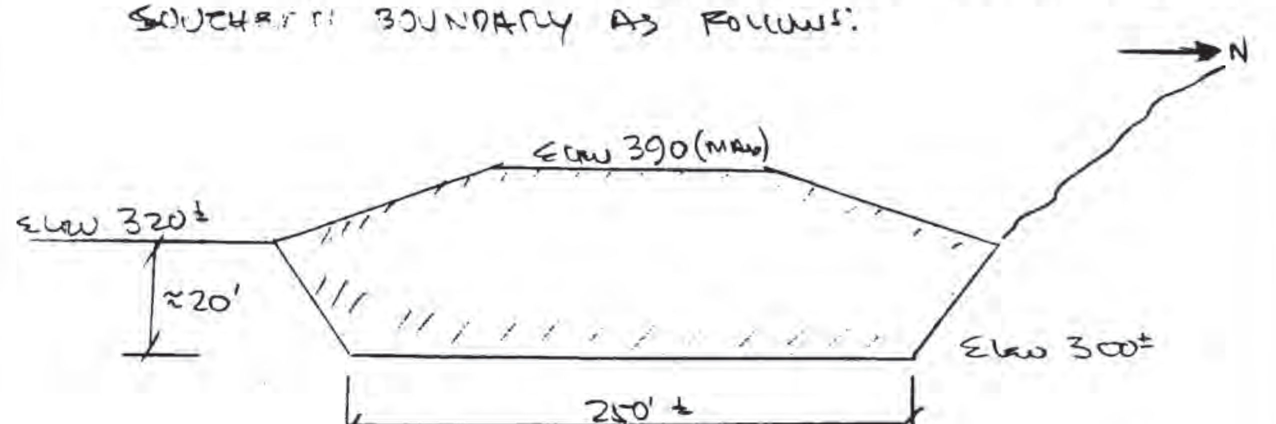
LANDFILL II : B511E-L20, , L27

LANDFILL MATERIAL WILL CONSIST OF BOTH STABILIZED & DIRECT DISPOSAL WASTE. ASSUME AVERAGE UNIT WEIGHT = 100 PCF

LANDFILL I

FROM SECTION C-C ON DRAWING B511E-L23, THE AVERAGE DEPTH OF LANDFILL IS APPROXIMATELY 90 FEET, AND THE AVERAGE DEPTH OF EXCAVATION BELOW EXISTING GRADE TO THE PROPOSED BASE OF LANDFILL IS 35 FEET.

REVIEW OF DWGS. L10 & L13 INDICATE THAT THE LEAST CONFINEMENT WITHIN LANDFILL I OCCURS ALONG ITS SOUTHERN BOUNDARY AS FOLLOWS:



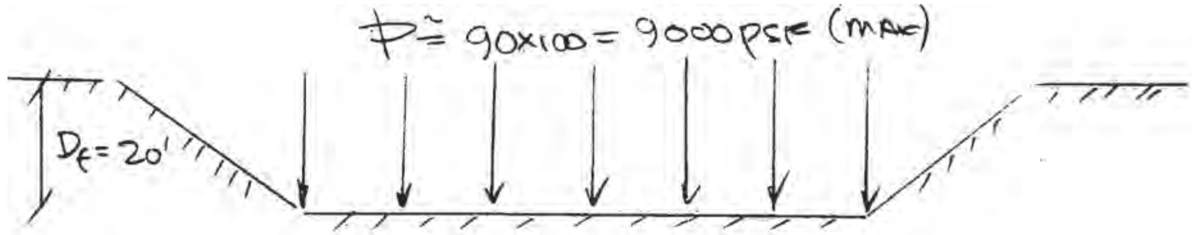

- NTS -

DETERMINE BEARING CAPACITY OF SUBSTRATA BASED ON THIS CONDITION WHICH IS MOST CRITICAL SECTION.

BY BMM DATE 1/6/86 | FRED C. HART ASSOCIATES, INC. | SHEET 12 OF 13 PAGE
CHK'D RCM DATE 1/29/86

SUBJECT PROTECO - GEOTECHNICAL EVALUATION JOB NO. B-511E
BEARING CAPACITY ANALYSIS - REVISED LANDFILLS

LOAD CONDITION




a) ASSUMING LAB PARAMETERS APPLY,

$\phi_u = 10°$, $C_u = 830$ psf } AVERAGE OF LAB TESTS

then, where $N_c = 9.6$, $N_q = 2.7$, $N_\gamma = 1.2$

$q_{ult} = cN_c + D_f(\gamma)N_q + \frac{1}{2}\gamma B N_\gamma$

$= 830(9.6) + 20(120)(2.7) + \frac{1}{2}(120)(250)(1.2)$

$= 7968 + 6480 + 18{,}000 = 32{,}448$

$q_{ult}/3 = 10{,}816$ psf $> 9000$ psf $\therefore$ OK FOR EXTREME CONDITION WHICH ASSUMES FOUNDATION CONSISTS OF RE-COMPACTED SITE MATERIAL UNDER INSTANTANEOUS LOADING CONDITION.

b) BASED ON PENETROMETER VALUE OF 3.9 TSF ; AND ASSUMING $\phi = 0°$

$q_{ult} = \left(\frac{3.9}{2} \text{ TSF}\right) \cdot 5.7 + \frac{20(120)(1.0)}{2000}$

$= (11.1 + 1.2)$ TSF $= 12.3$ TSF

$q_{allow} = 12.3/3 = 4.1$ TSF $< 4.5$ TSF BUT ADEQUATE FOR CONDITIONS ASSUMED

COMPUTED FACTOR OF SAFETY $= 12.3/4.5 = 2.7$

SINCE $\phi = 0$, CONSERVATIVE.

c)

FROM PRESUMPTIVE BEARING EVALUATION, THE APPLIED LANDFILL WEIGHT ([illegible]000 PSF — 4 TSF) IS LESS THAN 6 TSF

LANDFILL II

REVIEW OF THE REFERENCED DRAWINGS INDICATES THAT LOADING CONDITIONS IN LANDFILL II ARE LESS SEVERE THAN LANDFILL I, AND REQUIRES NO FURTHER EVALUATION.

CONCLUSION: THE SITE SUBSTRATA HAS SUFFICIENT STRENGTH TO SUSTAIN THE PROPOSED LANDFILL LOADS.

ITEM 2.

<u>SETTLEMENT ANALYSIS</u>

<u>LANDFILLS I & II</u>

(0655B-3)

| | | |
|---|---|---|
| BY B.M.M. DATE 1/24/86 <br> CHK'D RCM DATE 2/12/86 | **FRED C. HART ASSOCIATES, INC.** | SHEET 1 OF 6 PAGE |

SUBJECT PROTECO – GEOTECHNICAL EVALUATION JOB NO. B511E
SETTLEMENT ANALYSIS

PROBLEM STATEMENT

ASSESS THE POTENTIAL FOR SETTLEMENT OF THE SUBSTRATA & DETERMINE ITS EFFECT ON THE THE PROPOSED LINER SYSTEM.

ASSUMPTIONS & AVAILABLE DATA

1) ASSUME THAT SETTLEMENT WILL BE PRODUCED ONLY FROM THE RELATIVELY SOFT (HARD CLAY) STRATA THAT OVERLIES THE HARD LIMESTONE ENCOUNTERED AT VARYING DEPTHS WITHIN THE SITE. CONTOURS OF THE TOP OF LIMESTONE ARE PRESENTED ON UN-NUMBERED WORKSHEET.

2) REVIEW OF DWGS B511-L6 AND B511E-L10 INDICATE THAT THE "COMPRESSIBLE" STRATA UNDER LANDFILL I VARIES FROM NEAR 0 TO A MAXIMUM OF 50 FEET THICK IN A N→S DIRECTION BELOW THE BASE OF THE LANDFILL (≈ELEV 300)

3) REVIEW OF DWGS B511-L7 AND B511E-L16 INDICATES THAT THE "COMPRESSIBLE" STRATA UNDER LANDFILL II VARIES FROM 50 TO ABOUT 200 FEET THICK IN A NE→SW DIRECTION BELOW THE BASE OF THE LANDFILL.

4) GROUNDWATER LEVELS ON DWGS B-511E – L5, L6, & L7 INDICATE THAT GROUNDWATER IS ABOUT 10 FEET BELOW PROPOSED GRADE (BASE) AT BOTH LANDFILLS. FOR ANALYSIS, CAN ASSUME AT BASE (WORST CASE).

5) USE PREVIOUSLY DEVELOPED CONSOLIDATION PARAMETERS BASED ON SOIL CLASSIFICATION TESTS

ie $C_{CR} = 0.025$ $\gamma_{SAT} = 125$ pcf $\gamma_{w} = 62$ pcf

$P_C \gg$ PROPOSED STRESS INCREASES + $t_v$

BY BMM DATE 1/24/86 | FRED C. HART ASSOCIATES, INC. | SHEET 2 OF 6 PAGE

CHK'D RCN DATE 2/12/86

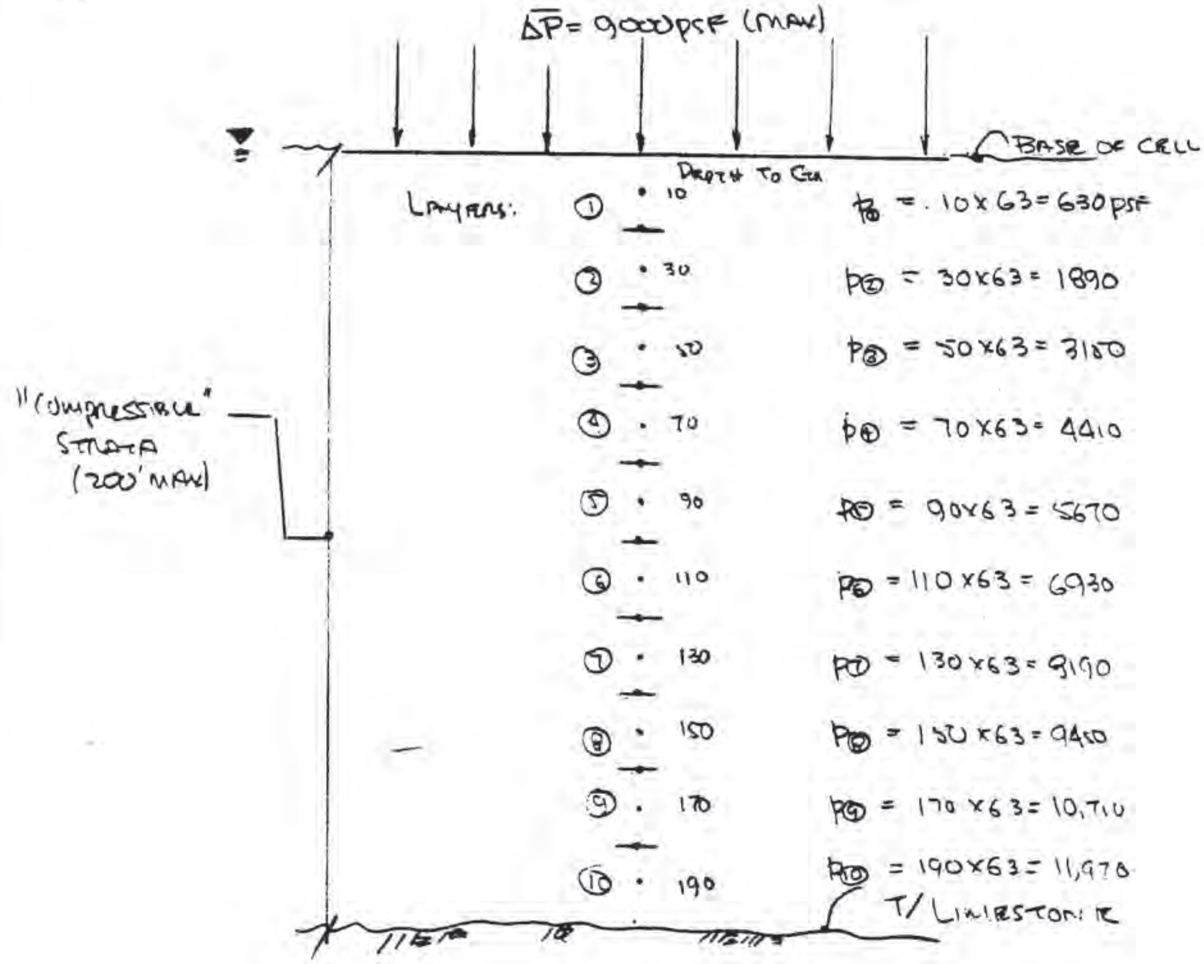
SUBJECT PROTECO – GEOTECHNICAL EVALUATION JOB NO. B511E

SETTLEMENT ANALYSIS

CALCULATIONS

A CONSERVATIVE ESTIMATE OF SETTLEMENTS (& DIFFERENTIALS) CAN BE MADE BY ASSUMING MAXIMUM LOADING CONDITIONS AND NO STRESS ATTENUATION WITH DEPTH DUE TO THE LARGE AREA OF LOADING. MAXIMUM FOUNDATION LOADING OCCURS IN LANDFILL I ≈ 9000 PSF.

∴




CALCULATE SETTLEMENT FOR EACH LAYER BY:

$$\Delta H = \frac{C_{cR}}{1+e_0}(H)\,\log\left(\frac{p_0+\Delta \bar{P}}{p_0}\right)$$

$\Delta \bar{P} = 9000$ psf

$C_{cR} = 0.025$

$e_0 = 0.70$

$H = 20(12) = 240$

$$\therefore \frac{C_{cR}}{1+e_0}(H) = 3.5$$

BY JEMM DATE 1/24/86 | FRED C. HART ASSOCIATES, INC. | SHEET 3 OF 6 PAGE
CHK'D RCM DATE 2/12/86

SUBJECT PROTECO – GEOTECHNICAL EVALUATION JOB NO. B-511E
SETTLEMENT ANALYSIS

CALCULATE SETTLEMENTS FOR VARIOUS LAYERS:

$\Sigma_{\Delta H}$

LAYER ① $\Delta H_1 = \underbrace{\frac{0.025}{1+.7}(20\times12)}_{3.5} \log\left(\frac{9000+630}{630}\right)$

$= 3.5 \times 1.18 = 4.13$ inches — 4.1"

② $\Delta H_2 = 3.5 \log\left(\frac{9000+1890}{1890}\right)$

$= 3.5 \times 0.76 = 2.7''$ — 6.8"

③ $\Delta H_3 = 3.5 \log\left(\frac{9000+3150}{3150}\right)$ — 8.9"

$= 3.5 \times 0.58 = 2.05''$

④ $\Delta H_4 = 3.5 \times \log\left(\frac{9000+4410}{4410}\right)$

$3.5 \times 0.48 = 1.7''$ — 10.6"

⑤ $\overline{\Delta H_5} = 3.5 \log\left(\frac{9000+5670}{5670}\right)$

$= 3.5 \times 0.41 = 1.4$ — 12.0"

⑥ $\overline{\Delta H_6} = 3.5 \log\left(\frac{9000+6930}{6930}\right)$

$3.5 \times 0.36 = 1.3$ — 13.3"

⑦ $\Delta H_7 = 3.5 \log\left(\frac{9000+8190}{8190}\right)$

$3.5 \times 0.32 = 1.1$ inch. — 14.4"

⑧ $\overline{\Delta H_8} = 3.5 \log\left(\frac{9000+9450}{9450}\right)$

$= 3.5 \times 0.29 = 1$ inch — 15.4"

| BY BCCM DATE 1/24/86 | FRED C. HART ASSOCIATES, INC. | SHEET 4 OF 6 PAGE |
|---|---|---|
| CHK'D RCM DATE 2/12/86 | | |

SUBJECT PROTECO – GEOTECHNICAL EVALUATION JOB NO. B-511E

SETTLEMENT ANALYSIS

(9) $\Delta H_9 = 3.5 \log \left( \frac{9000 + 10{,}710}{10{,}710} \right)$

$= 3.5 \times 0.26 = 0.9''$ 16.3 (19)

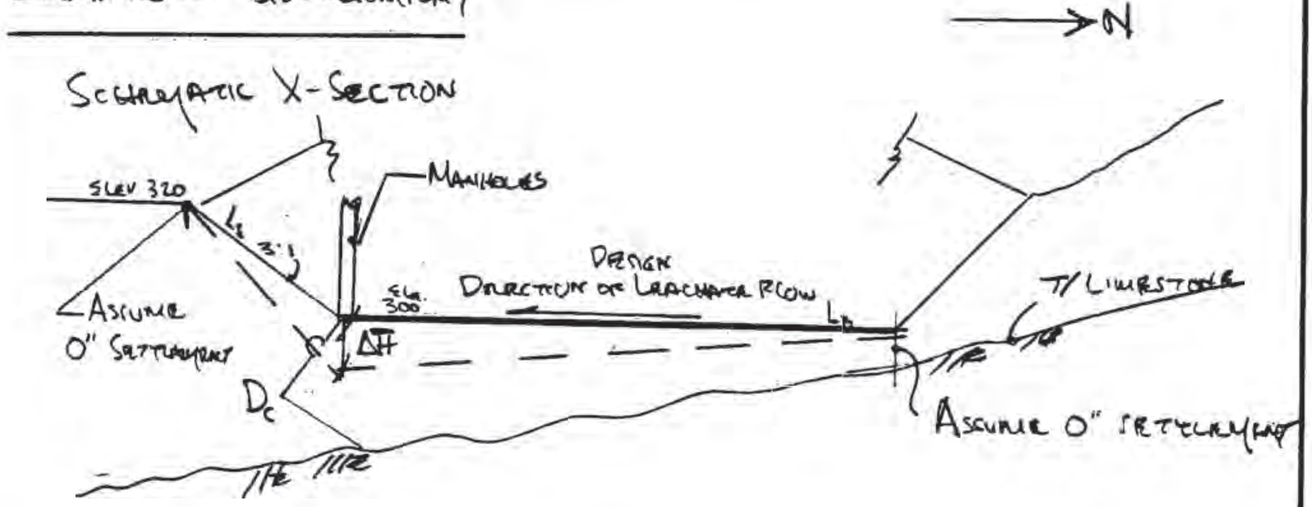
(10) $\Delta H_{10} = 3.5 \log \left( \frac{9000 + 11{,}970}{11{,}970} \right)$

$= 3.5 \times 0.24 = 0.8''$ - 17.1'' (20)

ASSUME ELASTIC RESPONSE NEGLIGIBLE RELATIVE TO CONSOLIDATION & ASSESS EFFECTS OF SETTLEMENT DIFFERENTIALS ON LANDFILLS I & II.

SETTLEMENT ANALYSIS
CALCULATION OF LINER STRAIN

LANDFILL I SETTLEMENT




$\overline{\Delta H}_{(MAX)} \cong 8''$ $D_{CLAY} \approx 50$ FEET

1) LENGTH OF BASE ≈ 250' $= L_B$

$\overline{\Delta L}$ OF LINER ALONG BASE $= (250^2+1^2)^{1/2} - 250 \cong 250$

∴ NO PROBLEM ALONG BASE

2) ASSUME LINER FIXED AT TOP OF SOUTH SLOPE

$$L_S = \left[(320-300)^2 + (\overset{3\cdot 20}{60})^2\right]^{1/2} = 63.24 \text{ FT.}$$

$$\Delta L \doteq \left[63.2^2 + 0.67^2\right]^{1/2} = 63.25 \text{ FT} - 63.24 = 0.01'$$

$$e = \Delta L/L = \frac{0.01}{63.2} = 0.02\% \quad \text{NEGLIGIBLE}$$

∴ DIFFERENTIAL SETTLEMENT NO PROBLEM WITH LINER ELONGATION & SETTLEMENT IS IN DIRECTION OF DESIGN FLOW OF LEACHATE SYSTEM.

| | | |
|---|---|---|
| BY BMM DATE 1/24/86<br>CHK'D RCM DATE 2/12/86 | **FRED C. HART ASSOCIATES, INC.** | SHEET 6 OF 6 PAGE |

SUBJECT PROTECO - GEOTECHNICAL EVALUATION JOB NO. B511E

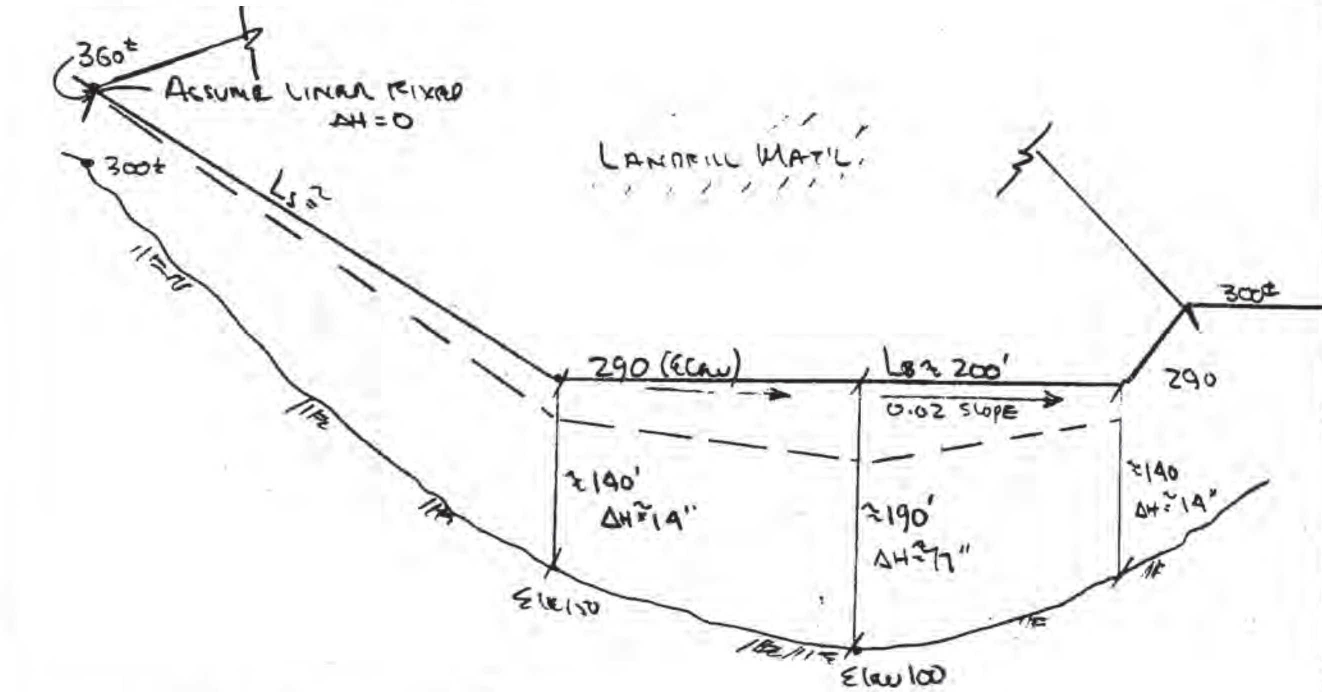
SETTLEMENT ANALYSIS

CALCULATION OF LINER STRAIN

## LANDFILL II SETTLEMENT

→ NE

SCHEMATIC X-SECTION




1) $L_s = \left[(360-\overset{70}{290})^2 + (70\times3)^2\right]^{1/2} = 221.4'$

$\Delta L \approx \left[221.4^2 + 1.2^2\right]^{1/2} - 221.4 = 0.3\%$ NEGLIGIBLE

2) GENERAL TREND OF SETTLEMENT WILL BE ADVERSE TO FLOW BUT SHOULD BE INSIGNIFICANT SINCE PIPING CAPACITY IS MUCH GREATER THAN DESIGN REQUIREMENTS

ITEM 3

STRESSES IN LINER FROM

LANDFILL SETTLEMENT

| BY RCM DATE 2/5/86<br>CHK'D BMM DATE 2/10/86 | FRED C. HART ASSOCIATES, INC. | SHEET 1 OF 2 | PAGE |
|---|---|---|---|

SUBJECT PROTECO GEOTECHNICAL EVALUATION JOB NO. B511

PROBLEM STATEMENT

DETERMINE LATERAL STRESSES DUE TO SETTLEMENT INDUCED STRAIN.

ASSUMPTIONS AND AVAILABLE DATA

LANDFILL 1 LINER STRAIN ≈ 0.08%
LANDFILL 2 LINER STRAIN ≈ 0.30% } SEE P. 405 FROM BMM WORK 1/24/86

80 MIL HDPE: MODULUS OF ELASTICITY = 110,000 PSI (GUNDLE)

SOLUTION

MAXIMUM TENSILE STRESS

LANDFILL 1: $\sigma_T = 110{,}000\,(.0008) = 88$ PSI

LANDFILL 2: $\sigma_T = 110{,}000\,(.0030) = 330$ PSI

80 MIL HDPE TENSILE STRENGTH AT YIELD = 190 P/IN. WIDTH (GUNDLE)

80 MIL HDPE TENSILE STRENGTH AT BREAK = 320 P/IN. WIDTH (GUNDLE)

80 MIL $\left(\frac{.001\ IN}{MIL}\right)(1\ IN) = 0.08\ IN^2/IN.\ WIDTH$

LANDFILL 1: $\sigma_T$ / IN. WIDTH = 88 PSI ($.08\ IN^2/IN.\ WIDTH$)

= 7.0 P/IN. WIDTH << 190 OK

LANDFILL 2: $\sigma_T$ / IN. WIDTH = 330 PSI ($.08\ IN^2/IN.\ WIDTH$)

= 26.4 P/IN. WIDTH << 190 OK

CONCLUSION

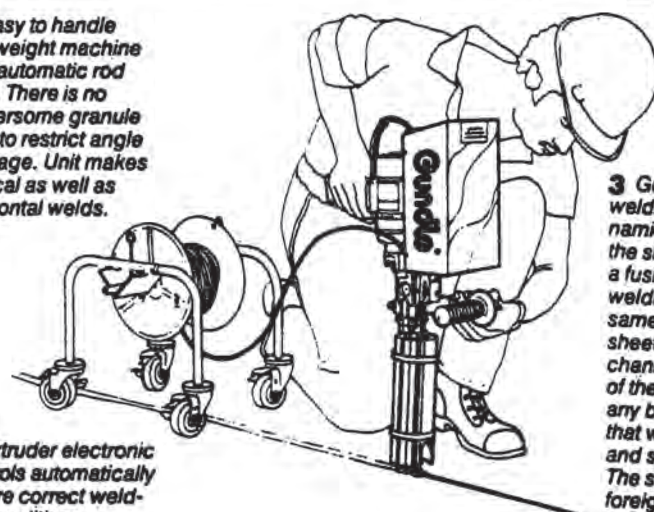
TENSILE STRESSES IN HDPE LINERS UNDERLYING LANDFILLS 1 AND 2 ARE LESS THAN THE TENSILE STRESS AT YIELD AS QUOTED BY THE MANUFACTURER (GUNDLE). THE TENSILE ARE THEREFORE ACCEPTABLE.

SHEET 2 of 2

# Gundle Fusion Welding: the process which consistently gives you seams strong and as durable as the sheet.

Until now, the most failure-prone part of flexible membrane liners has been the seam. Various bonding methods have been used, but none could produce a seam that would withstand as much physical stress and weathering as the sheet itself. Now Gundle has the answer: Gundle Fusion Welding... a patented, field-applied process. Its effectiveness has been proven repeatedly in rigorous laboratory tests and in successful field applications worldwide.

*For more detailed information request a copy of our Gundline® Flexible Membrane Lining Systems brochure.*




*1 Easy to handle lightweight machine with automatic rod feed. There is no bothersome granule feed to restrict angle of usage. Unit makes vertical as well as horizontal welds.*

*2 Extruder electronic controls automatically assure correct welding conditions.*

*3 Gundle's unique welding method dynamically integrates the sheets. It creates a fusion weld using welding rod of the same material as the sheet itself. This mechanical integration of the sheets eliminates any boundary layers that would be weak and subject to failure. The system uses no foreign solvents or adhesives which can degenerate over time.*

## SPECIFICATIONS

| PROPERTY | TEST METHOD | GAUGE (NOMINAL) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 20 Mil | 30 Mil | 40 Mil | 60 Mil | 80 Mil | 100 Mil |
| Density (g/cc) (Minimum) | ASTM D1505 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Minimum Tensile Properties (Each direction) | ASTM D638 Type IV Dumb-bell at 2 ipm. | | | | | | |
| 1. Tensile Strength at Break (Pounds/inch width) | | 80 | 120 | 160 | 240 | 320 | 400 |
| 2. Tensile Strength at Yield (Pounds/inch width) | | 50 | 70 | 95 | 140 | 190 | 240 |
| 3. Elongation at Break (Percent) | | 700 | 700 | 700 | 700 | 700 | 700 |
| 4. Elongation at Yield (Percent) | | 13 | 13 | 13 | 13 | 13 | 13 |
| 5. Modulus of Elasticity (Pounds/square inch) | ASTM D882 | 110,000 | 110,000 | 110,000 | 110,000 | 110,000 | 110,000 |
| Tear Resistance Initiation (Pounds minimum) | ASTM D1004 Die C | 15 | 22 | 30 | 45 | 60 | 75 |
| Low Temperature | ASTM D746 Procedure B | −40°F | −40°F | −40°F | −40°F | −40°F | −40°F |
| Dimensional Stability (Each direction, percent change maximum) | ASTM D1204 212°F 1 hr. | ±2 | ±2 | ±2 | ±2 | ±2 | ±2 |
| Volatile Loss (Maximum %) | ASTM D1203 Method A | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Environmental Stress Crack (Minimum hours) | ASTM D1693 | 750 | 750 | 750 | 750 | 750 | 750 |

ITEM 4

STABILITY ANALYSIS OF LANDFILLS

(0655B-5)

| BY RCM DATE 1/25/86 | FRED C. HART ASSOCIATES, INC. | SHEET 1 OF 5 | PAGE |
|---|---|---|---|
| CHK'D BMM DATE 2/10/86 | | | |

SUBJECT PROTECO SLOPE STABILITY - LANDFILL 1 JOB NO. B511E

PROBLEM

DETERMINE THE STABILITY OF LANDFILL 1.

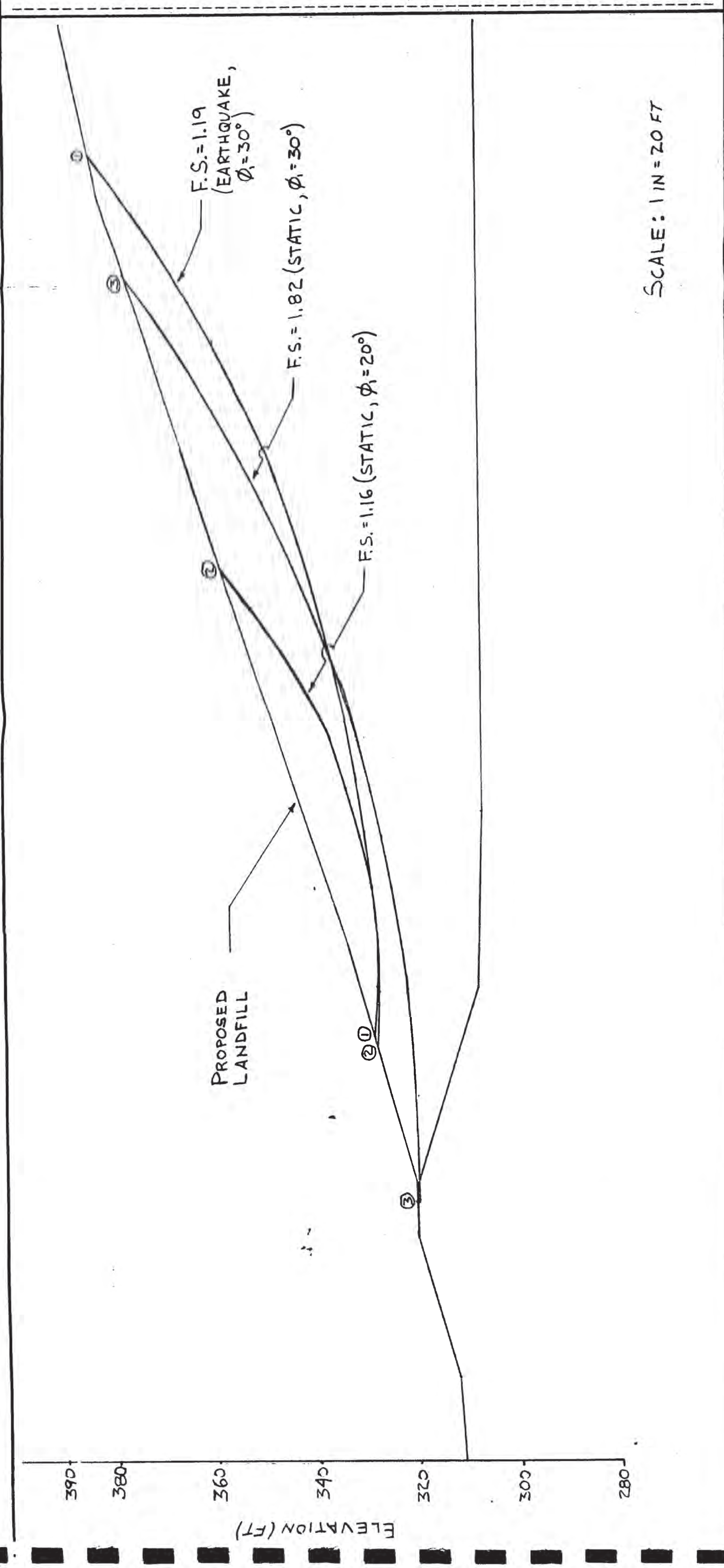

SUMMARY

THE SLOPE WAS ANALYZED BY USING THE STABL3 COMPUTER PROGRAM. STABL3 USES THE SIMPLIFIED METHOD OF SLICES (JANBU). SOIL PARAMETERS ARE FROM NAVFAC AS NOTED. HDPE AND GEOFABRICS WERE CUT IN HALF SUCH THAT POTENTIAL CRITICAL FAILURE SURFACES COULD BE GENERATED. THE SURFACES WERE EXPECTED TO BE GENERATED ALONG SOIL/LINER INTERFACES, BUT NONE COULD BE GENERATED. POTENTIAL CRITICAL FAILURE SURFACES FOR THE STATIC CASE EXCEEDED THE RECOMMENDED F.S. OF 1.5. EARTHQUAKE FACTOR OF SAFETY OF 1.2 EXCEEDS THE RECOMMENDED VALUE OF 1.1. HENCE, THE PROPOSED LANDFILL IS ACCEPTABLE FROM A SLOPE STABILITY STANDPOINT.

BY RCM DATE 2/5/86 | **FRED C. HART ASSOCIATES, INC.** | SHEET ___ OF ___ PAGE

CHK'D ______ DATE ______

SUBJECT PROTECO SLOPE STABILITY LANDFILL 1 JOB NO. 8511



| BY RCM DATE 1/23/86<br>CHK'D BMM DATE 2/10/86 | FRED C. HART ASSOCIATES, INC. | SHEET 3 OF 6 | PAGE |
|---|---|---|---|

SUBJECT PROTECO SLOPE STABILITY - LANDFILL 1 JOB NO. BS11E

1) SECTION C-C (BS11E-L23)
TOPOGRAPHIC MAP CONTAINING CUT C-C (BS11E-L13)

2) SECTION C-C IS ASSUMED PERPENDICULAR TO DIRECTION OF POSSIBLE INSTABILITY. THE INSTABILITY WOULD MOST PROBABLY OCCUR SOUTH OF LANDFILL 1. LANDFILL 1 IS MORE CRITICAL SINCE IT IS HIGHER THAN LANDFILL 2.

3) SOIL STRENGTH PARAMETERS USED ARE CONSERVATIVE CONSIDERING
   A) WATER TABLE DEPTH IS BELOW POTENTIAL CRITICAL FAILURE SURFACES.
   B) UNCONSOLIDATED UNDRAINED TEST RESULTS ARE CONSERVATIVE SINCE LANDFILL WILL NOT BE FILLED INSTANTANEOUSLY BUT OVER A PERIOD OF TIME. HENCE, A VALUE OF $\phi = 20°$ IS MORE APPROPIATE THAN UU VALUE OF 3.2° FOR RECOMPACTED CLAY.
   C) EVEN WITH CONSERVATIVE VALUES FOR SOIL STRENGTH PARAMETERS THE CONTROLLING POTENTIAL CRITICAL FAILURE SURFACE IS THE LANDFILL REFUSE MATERIAL.

BY RCM DATE 1/23/86

CHK'D BMM DATE 2/10/86

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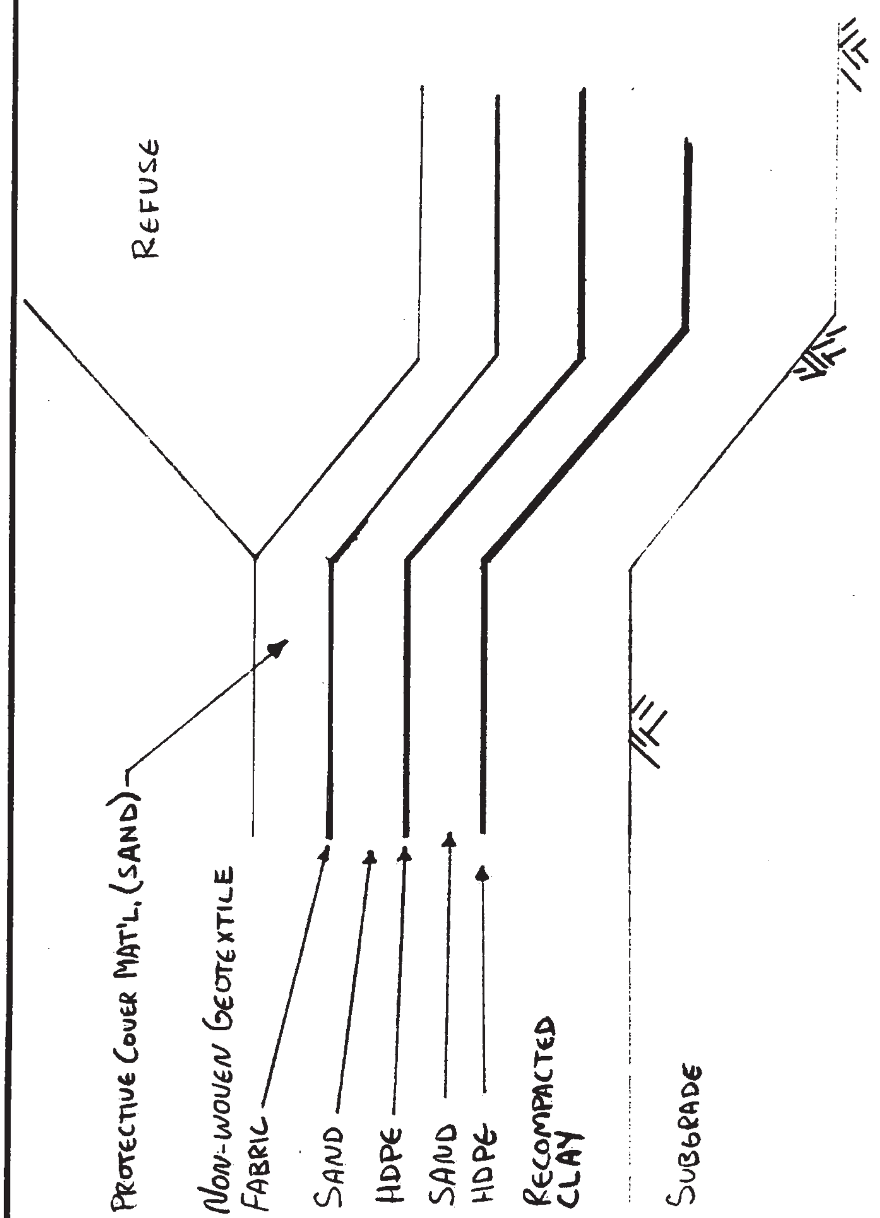
SHEET 4 OF 6 PAGE

SUBJECT PROTECO SLOPE STABILITY - LANDFILL 1 JOB NO. BSIE




DETAIL OF INTERIM BERM, LANDFILL 1 (FROM SECTION C-C)

NOTE: NOT TO SCALE

BY RCM DATE 1/23/86 | FRED C. HART ASSOCIATES, INC. | SHEET 5 OF 6 PAGE

CHK'D BMM DATE 2/10/86

SUBJECT PROTECO SLOPE STABILITY - LANDFILL 1 JOB NO. B511E

LAYER PROPERTIES

SUBGRADE

TYPICAL SUBGRADE IS CH

FROM TABLE 9-1 NAVFAC

$\phi' \sim 19°$

c (as compacted) ~ 2150 psf

c' (saturated) ~ 230 psf

PIEZOMETRIC SURFACE AT 280'-290'

∴ USE 285' FOR PIEZOMETRIC SURFACE

DIVIDE SUBGRADE INTO 2 LAYERS FOR ANALYSIS

- TOP PORTION OF SUBGRADE $\phi' = 20$, c = 2000 PSF

WHERE c = 2000 PSF < 2150 PSF

- BOTTOM PORTION OF SUBGRADE $\phi = 20$, c = 2000 PSF

RECOMPACTED CLAY

SAMPLE 1M2-S2 RECOMPACTED CLAY BY MOD PROCTOR

$\phi_w = 3.2°$, $c_w = 1150$ PSF BUT c' = 2000 PSF, $\phi' = 20$ MORE APP.

80 MIL HDPE PRIMARY LINER 80 MIL = 3.15 IN ~ 0.26 FT

FRICTION ANGLE BETWEEN REC. CLAY AND HDPE ~ 0°

ASSUME ADHESION OF c = 1150 PSF SEE P.5

FRICTION ANGLE BETWEEN SAND AND HDPE FROM

INTERNATIONAL CONF. ON GEOMEMBRANES

MARTIN, KOERNER, AND WHITTY p. 193

$\phi = 18°$ (CONSERVATIVE, FOR SAND WITH $\phi = 30°$)

c = 0 (SAND COHESIONLESS)

ASSUME $\phi = 18°$ (SAME AS SAND/HDPE INTERFACE) SINCE NO AVAILABLE DATA ON ADHESION

SAND LAYERS

FREE DRAINING SAND $\phi = 30°$, c = 0

15 IN = 1.25 FT FOR DRAINAGE AND DRAINAGE DETECTION LAYER

12 IN = 1.00 FT FOR SAND AS PROTECTIVE MATERIAL COVER

| BY RCM DATE 1/23/96 | FRED C. HART ASSOCIATES, INC. | SHEET 6 OF 6 PAGE |
|---|---|---|
| CHK'D BMM DATE 2/10/96 | | |

SUBJECT PROTECO SLOPE STABILITY - LANDFILL I JOB NO. B511E

LAYER PROPERTIES

NON-WOVEN GEOTEXTILE FABRIC

FRICTION ANGLE BETWEEN SAND AND GEOTEXTILE

$\phi = 30°$ FOR CZ600 AND $\phi = 26°$ FOR TYPAR 3401

USE $\phi = 26°$ (WORST CASE)

Table 1

| Zone | Damage | Coefficient |
| --- | --- | --- |
| 0 | None | 0.0 |
| 1 | Minor | 0.05 |
| 2 | Moderate | 0.10 |
| 3 | Major | 0.15 |
| 4 | Great | 0.20 |

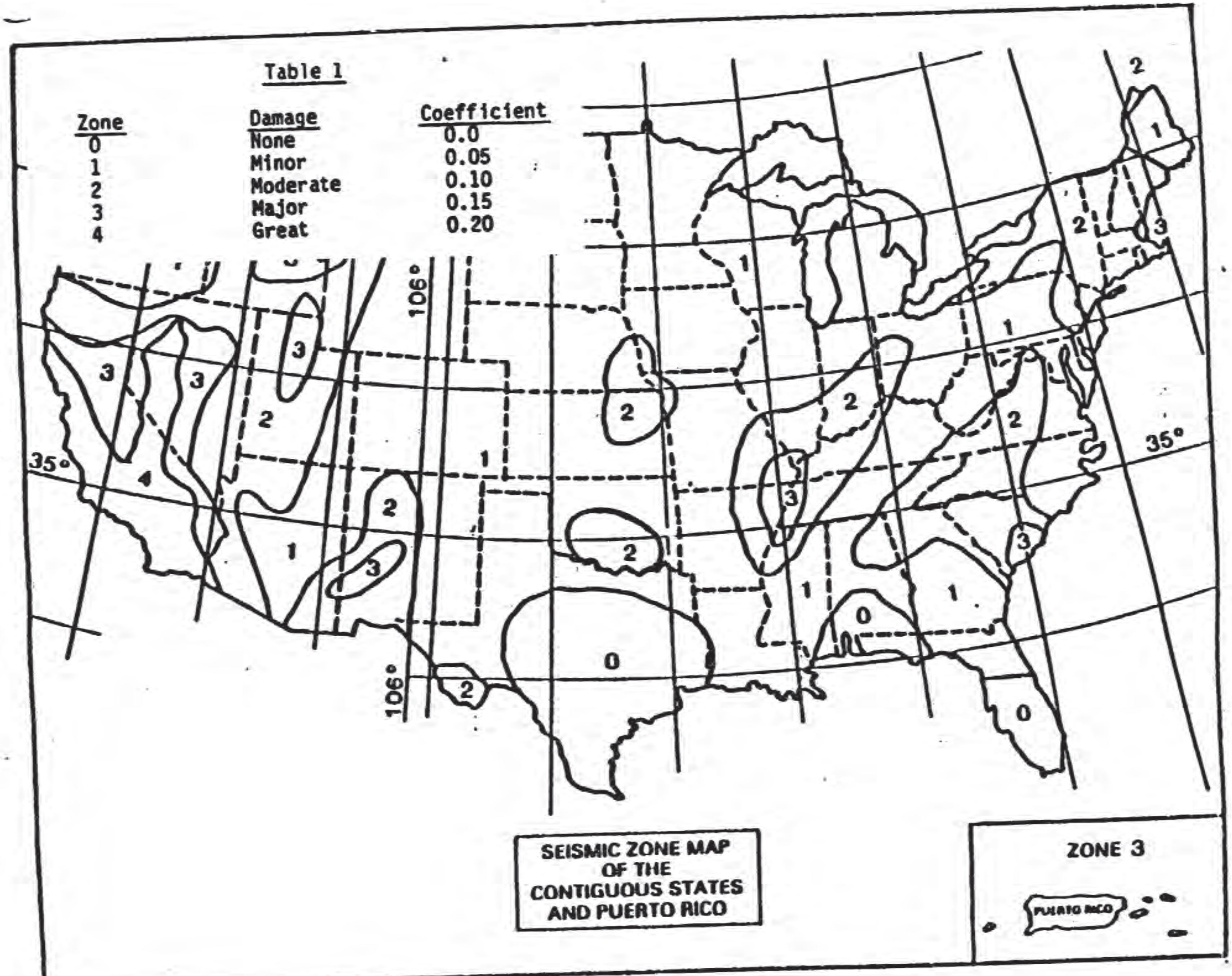



Figure A-1

# TABLE 9-1
## Typical Properties of Compacted Materials

| Group symbol | Soil type | Range of maximum dry unit weight, pcf | Range of optimum moisture, percent | Typical value of compression: At 1.4 tsf (20 psi) — percent of original height | Typical value of compression: At 3.6 tsf (50 psi) — percent of original height | Typical strength characteristics: UU Cohesion (as compacted) psf | Typical strength characteristics: C' Cohesion (saturated) psf | Typical strength characteristics: φ(Effective stress envelope) degrees | Typical strength characteristics: Tan φ | Typical coefficient of permeability ft/min. | Range of CBR values | Range of subgrade modulus k lb/cu in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Well graded clean gravels, gravel-sand mixtures. | 125 - 135 | 11 - 8 | 0.3 | 0.6 | 0 | 0 | >38 | >0.79 | $5 \times 10^{-2}$ | 40 - 80 | 300 - 500 |
| GP | Poorly graded clean gravels, gravel-sand mix. | 115 - 125 | 14 - 11 | 0.4 | 0.9 | 0 | 0 | >37 | >0.74 | $10^{-1}$ | 30 - 60 | 250 - 400 |
| GM | Silty gravels, poorly graded gravel-sand-silt. | 120 - 135 | 12 - 8 | 0.5 | 1.1 | .......... | .......... | >34 | >0.67 | $>10^{-6}$ | 20 - 60 | 100 - 400 |
| GC | Clayey gravels, poorly graded gravel-sand-clay. | 115 - 130 | 14 - 9 | 0.7 | 1.6 | .......... | .......... | >31 | >0.60 | $>10^{-7}$ | 20 - 40 | 100 - 300 |
| SW | Well graded clean sands, gravelly sands. | 110 - 130 | 16 - 9 | 0.6 | 1.2 | 0 | 0 | 38 | 0.79 | $>10^{-3}$ | 20 - 40 | 200 - 300 |
| SP | Poorly graded clean sands, sand-gravel mix. | 100 - 120 | 21 - 12 | 0.8 | 1.4 | 0 | 0 | 37 | 0.74 | $>10^{-3}$ | 10 - 40 | 200 - 300 |
| SM | Silty sands, poorly graded sand-silt mix. | 110 - 125 | 16 - 11 | 0.8 | 1.6 | 1050 | 420 | 34 | 0.67 | $5 \times 10^{-5}$ | 10 - 40 | 100 - 300 |
| SM-SC | Sand-silt clay mix with slightly plastic fines. | 110 - 130 | 15 - 11 | 0.8 | 1.4 | 1050 | 300 | 33 | 0.66 | $2 \times 10^{-6}$ | .......... | |
| SC | Clayey sands, poorly graded sand-clay mix. | 105 - 125 | 19 - 11 | 1.1 | 2.2 | 1550 | 230 | 31 | 0.60 | $5 \times 10^{-7}$ | 5 - 20 | 100 - 300 |
| ML | Inorganic silts and clayey silts . | 95 - 120 | 24 - 12 | 0.9 | 1.7 | 1400 | 190 | 32 | 0.62 | $10^{-5}$ | 15 or less | 100 - 200 |
| ML-CL | Mixture of inorganic silt and clay | 100 - 120 | 22 - 12 | 1.0 | 2.2 | 1350 | 460 | 32 | 0.62 | $5 \times 10^{-7}$ | .......... | |
| CL | Inorganic clays of low to med. plasticity. | 95 - 120 | 24 - 12 | 1.3 | 2.5 | 1800 | 270 | 28 | 0.54 | $10^{-7}$ | 15 or less | 50 - 200 |
| OL | Organic silts and silt-clays, low plasticity. | 80 - 100 | 33 - 21 | ........ | ........ | .......... | .......... | .......... | ..... | .......... | 5 or less | 50 - 100 |
| MH | Inorganic clayey silts, elastic silts. | 70 - 95 | 40 - 24 | 2.0 | 3.8 | 1500 | 420 | 25 | 0.47 | $5 \times 10^{-7}$ | 10 or less | 50 - 100 |
| CH | Inorganic clays of high plasticity | 75 - 105 | 36 - 19 | 2.6 | 3.9 | 2150 | 230 | 19 | 0.35 | $10^{-7}$ | 15 or less | 50 - 150 |
| OH | Organic clays and silty clays . . . | 65 - 100 | 45 - 21 | ........ | ........ | .......... | .......... | .......... | ..... | .......... | 5 or less | 25 - 100 |

Avg 325 psf 22°

Notes:
1. All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown. (....) indicates insufficient data available for an estimate.

linear and the data spread in a given locus of points was nominal.

After each shear failure, the direction of deformation was reversed, and the test repeated. The purpose of this exercise was to indicate residual friction angles where membrane tension is alternately increased and reduced as the level of a storage lagoon changes. Such reversals of strain direction may tend to align particles along the shear plane, and reduce slip resistance. However, the difference between initial and repeated shear strengths was negligible in all cases.(3)

MATERIALS TESTED AND RESULTS

Three granular soil types were used in these tests:

(1) Ottawa sand (SP) with $d_{10}$ = 0.42 mm; CU = 1.9 and rounded particle shapes.
(2) Concrete sand (SP) with $d_{10}$ = 0.20 mm; CU = 2.6 and angular particle shapes.
(3) Mica schist silty sand (SM) with $d_{10}$ = 0.037 mm; CU = 5.1 and angular particle shapes.

Thus the three soil types selected give a contrast in particle shape, size and uniformity. They are limited however, to granular soils with essentially no plasticity.

Four types of geomembranes (using five separate surfaces) were used in these tests. They were all tested in their manufactured directions.

(1) High density polyethylene (HDPE) which was 20 mils thick and can be characterized as being stiff, hard and smooth as far as physical or frictional characteristics are concerned.
(2) Ethylene propylene diene monomer (EPDM) which was 30 mils thick and can be characterized as being flexible, soft and smooth.
(3) Polyvinyl chloride (PVC) which was 30 mils thick and characterized as being of medium stiffness and hardness and rough on one side while smooth on the other side. Both sides were used during these tests.
(4) Chlorosulfonated polyethylene (CSPE) which was reinforced with a fabric scrim and was 36 mils thick. It is characterized as being of medium stiffness and hardness, but was of wavy roughness due to the laminated 10 x 10 scrim reinforcement contained within it.

Four types of geotextiles were used in these tests which represented each of the general manufacturing classifications of these materials.(6) They were all tested in their manufactured directions.

(1) Woven monofilament polypropylene fabric (Carthage Mills Polyfilter X) which is characterized as being a thin, stiff fabric with a relatively high percent open area as far as physical or frictional characteristics are concerned.
(2) Woven silt film (tape) polypropylene fabric (Mirafi 500 X) which is characterized as being a thin, flexible fabric with a low percent open area.
(3) Nonwoven heat set polypropylene fabric (duPont 3401) which is characterized as being a thin, flexible fabric with a relatively low open area.
(4) Nonwoven needled polypropylene fabric (Crown Zellerbach 600) which is characterized as being a compressible, thick, bulky, very flexible fabric with a relatively high open area.

These three soil types, four geomembrane types and four geotextile types were tested within their own categories and against one another in the manner described in the previous section. The results are given in Table 1 in two ways. The principal information (for design purposes) is given as angular values of friction angle: "$\phi$" values for the soil by itself and "$\delta$" values for the composite behavior. In parenthesis is given the relative amount (for comparison purposes) of mobilized soil strength that the geomembrane or geotextile gives, i.e.,

$$E = \frac{\tan \delta}{\tan \phi}$$

where

$E$ = efficiency ratio
$\tan \delta$ = tangent of soil to material friction angle
$\tan \phi$ = tangent of soil friction angle, where
$\tau = c + \overline{\sigma}_n \tan \phi$
$c$ = cohesion (zero for these granular soils)
$\overline{\sigma}_n$ = effective normal stress

Table 1 - Summary of Friction Angle and Efficiencies (in Parentheses) For Soils, Geomembranes and Geotextiles Testing in this Study

(a) Soil to Geomembrane Friction Angles

| Soil / Geomembrane | Concrete Sand ($\phi$ = 30°) | Ottawa Sand ($\phi$ = 28°) | Mica Schist ($\phi$ = 26°) |
|---|---|---|---|
| EPDM | 24° (.80) | 20° (.71) | 24° (.92) |
| PVC (Rough) | 27° (.90) | - | 25° (.96) |
| PVC (Smooth) | 25° (.83) | - | 21° (.81) |
| CSPE | 25° (.83) | 21° (.75) | 23° (.88) |
| HDPE | 18° (.60) | 18° (.64) | 17° (.65) |

(b) Soil to Geotextile Friction Angles

| Soil / Geomembrane | Concrete Sand ($\phi$ = 30°) | Ottawa Sand ($\phi$ = 28°) | Mica Schist ($\phi$ = 26°) |
|---|---|---|---|
| CZ 600 | 30° (1.00) | 26° (.93) | 25° (.96) |
| Typar 3401 | 26° (.87) | - | - |
| Polyfilter X | 26° (.87) | - | - |
| 500 X | 24° (.80) | 24° (.86) | 23° (.88) |

(c) Geomembrane to Geotextile Friction Angles

| Geomembrane / Geotextile | EPDM | PVC (R) | PVC (S) | CSPE | HDPE |
|---|---|---|---|---|---|
| CZ 600 | 23° | 23° | 21° | 15° | 8° |
| Typar 3401 | 18° | 20° | 18° | 21° | 11° |
| Polyfilter X | 17° | 11° | 10° | 9° | 6° |
| 500 X | 21° | 28° | 24° | 13° | 10° |

INTERPRETATION OF RESULTS

Table 1, parts "a" and "b" show the results of the direct shear tests for friction between various soils and synthetic materials in terms of friction angle ($\phi$ or $\delta$)

| BOUNDARY NO. | X-LEFT (FT) | Y-LEFT (FT) | X-RIGHT (FT) | Y-RIGHT (FT) | SOIL TYPE BELOW BND |
|---|---|---|---|---|---|
| 1 | .00 | 31.04 | 116.00 | 32.04 | 2 |
| 2 | 116.00 | 32.04 | 143.00 | 40.04 | 2 |
| 3 | 143.00 | 40.04 | 153.00 | 40.04 | 2 |
| 4 | 153.00 | 40.04 | 198.00 | 53.00 | 1 |
| 5 | 198.00 | 53.00 | 345.00 | 103.10 | 1 |
| 6 | 345.00 | 103.10 | 440.00 | 123.00 | 1 |
| 7 | 440.00 | 123.00 | 543.00 | 109.00 | 1 |
| 8 | 153.00 | 40.04 | 191.00 | 28.04 | 2 |
| 9 | 191.00 | 28.04 | 224.00 | 27.04 | 2 |
| 10 | 224.00 | 27.04 | 388.00 | 28.04 | 2 |
| 11 | 388.00 | 28.04 | 415.00 | 37.04 | 2 |
| 12 | 415.00 | 37.04 | 426.00 | 37.04 | 2 |
| 13 | 426.00 | 37.04 | 460.00 | 27.04 | 2 |
| 14 | 460.00 | 27.04 | 543.00 | 27.04 | 2 |
| 15 | .00 | 30.04 | 116.00 | 31.04 | 3 |
| 16 | 116.00 | 31.04 | 143.00 | 39.04 | 3 |
| 17 | 143.00 | 39.04 | 153.00 | 39.04 | 3 |
| 18 | 153.00 | 39.04 | 191.00 | 27.04 | 3 |
| 19 | 191.00 | 27.04 | 224.00 | 26.04 | 3 |
| 20 | 224.00 | 26.04 | 388.00 | 27.04 | 3 |
| 21 | 388.00 | 27.04 | 415.00 | 36.04 | 3 |
| 22 | 415.00 | 36.04 | 426.00 | 36.04 | 3 |
| 23 | 426.00 | 36.04 | 460.00 | 26.04 | 3 |
| 24 | 460.00 | 26.04 | 543.00 | 26.04 | 3 |
| 25 | .00 | 30.02 | 116.00 | 31.02 | 2 |
| 26 | 116.00 | 31.02 | 143.00 | 39.02 | 2 |
| 27 | 143.00 | 39.02 | 153.00 | 39.02 | 2 |
| 28 | 153.00 | 39.02 | 191.00 | 27.02 | 2 |
| 29 | 191.00 | 27.02 | 224.00 | 26.02 | 2 |
| 30 | 224.00 | 26.02 | 388.00 | 27.02 | 2 |
| 31 | 388.00 | 27.02 | 415.00 | 36.02 | 2 |
| 32 | 415.00 | 36.02 | 426.00 | 36.02 | 2 |
| 33 | 426.00 | 36.02 | 460.00 | 26.02 | 2 |
| 34 | 460.00 | 26.02 | 543.00 | 26.02 | 2 |
| 35 | .00 | 28.52 | 116.00 | 29.52 | 4 |
| 36 | 116.00 | 29.52 | 143.00 | 37.52 | 4 |
| 37 | 143.00 | 37.52 | 153.00 | 37.52 | 4 |
| 38 | 153.00 | 37.52 | 191.00 | 25.52 | 4 |
| 39 | 191.00 | 25.52 | 224.00 | 24.52 | 4 |
| 40 | 224.00 | 24.52 | 388.00 | 25.52 | 4 |
| 41 | 388.00 | 25.52 | 415.00 | 34.52 | 4 |

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| | | | | | |
|---|---|---|---|---|---|
| 43 | 426.00 | 34.52 | 460.00 | 24.52 | 4 |
| 44 | 460.00 | 24.52 | 543.00 | 24.52 | 4 |
| 45 | .00 | 28.51 | 116.00 | 29.51 | 2 |
| 46 | 116.00 | 29.51 | 143.00 | 37.51 | 2 |
| 47 | 143.00 | 37.51 | 153.00 | 37.51 | 2 |
| 48 | 153.00 | 37.51 | 191.00 | 25.51 | 2 |
| 49 | 191.00 | 25.51 | 224.00 | 24.51 | 2 |
| 50 | 224.00 | 24.51 | 388.00 | 25.51 | 2 |
| 51 | 388.00 | 25.51 | 415.00 | 34.51 | 2 |
| 52 | 415.00 | 34.51 | 426.00 | 34.51 | 2 |
| 53 | 426.00 | 34.51 | 460.00 | 24.51 | 2 |
| 54 | 460.00 | 24.51 | 543.00 | 24.51 | 2 |
| 55 | .00 | 27.04 | 116.00 | 28.04 | 4 |
| 56 | 116.00 | 28.04 | 143.00 | 36.04 | 4 |
| 57 | 143.00 | 36.04 | 153.00 | 36.04 | 4 |
| 58 | 153.00 | 36.04 | 191.00 | 25.04 | 4 |
| 59 | 191.00 | 25.04 | 224.00 | 24.04 | 4 |
| 60 | 224.00 | 24.04 | 388.00 | 25.04 | 4 |
| 61 | 388.00 | 25.04 | 415.00 | 34.04 | 4 |
| 62 | 415.00 | 34.04 | 426.00 | 34.04 | 4 |
| 63 | 426.00 | 34.04 | 460.00 | 24.04 | 4 |
| 64 | 460.00 | 24.04 | 543.00 | 24.04 | 4 |
| 65 | .00 | 27.02 | 116.00 | 28.02 | 5 |
| 66 | 116.00 | 28.02 | 143.00 | 36.02 | 5 |
| 67 | 143.00 | 36.02 | 153.00 | 36.02 | 5 |
| 68 | 153.00 | 36.02 | 191.00 | 25.02 | 5 |
| 69 | 191.00 | 25.02 | 224.00 | 24.02 | 5 |
| 70 | 224.00 | 24.02 | 388.00 | 25.02 | 5 |
| 71 | 388.00 | 25.02 | 415.00 | 34.02 | 5 |
| 72 | 415.00 | 34.02 | 426.00 | 34.02 | 5 |
| 73 | 426.00 | 34.02 | 460.00 | 24.02 | 5 |
| 74 | 460.00 | 24.02 | 543.00 | 24.02 | 5 |
| 75 | .00 | 27.00 | 116.00 | 28.00 | 6 |
| 76 | 116.00 | 28.00 | 143.00 | 36.00 | 6 |
| 77 | 143.00 | 36.00 | 153.00 | 36.00 | 6 |
| 78 | 153.00 | 36.00 | 191.00 | 25.00 | 6 |
| 79 | 191.00 | 25.00 | 224.00 | 24.00 | 6 |
| 80 | 224.00 | 24.00 | 388.00 | 25.00 | 6 |
| 81 | 388.00 | 25.00 | 415.00 | 34.00 | 6 |
| 82 | 415.00 | 34.00 | 426.00 | 34.00 | 6 |
| 83 | 426.00 | 34.00 | 460.00 | 24.00 | 6 |
| 84 | 460.00 | 24.00 | 543.00 | 24.00 | 6 |
| 85 | .00 | 23.00 | 116.00 | 24.00 | 7 |
| 86 | 116.00 | 24.00 | 268.00 | 20.00 | 7 |
| 87 | 268.00 | 20.00 | 378.00 | 22.00 | 7 |
| 88 | 378.00 | 22.00 | 501.00 | 18.50 | 7 |
| 89 | 501.00 | 18.50 | 543.00 | 18.50 | 7 |

1 ISOTROPIC SOIL PARAMETERS

7 TYPE(S) OF SOIL

| SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | $\phi$ FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | P ZOMETRIC URFACE NO. |
|---|---|---|---|---|---|---|---|
| 1 | 100.0 | 100.0 | .0 | $\phi_1$=30.0 | .00 | .0 | 1 |
| 2 | 120.0 | 130.0 | .0 | 30.0 | .00 | .0 | 1 |
| 3 | 140.0 | 140.0 | .0 | 26.0 | .00 | .0 | |

1

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | 140.0 | 140.0 | .0 | 18.0 | .00 | .0 |
| 5 | 140.0 | 140.0 | .0 | 18.0 | .00 | .0 |
| 6 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 |
| 7 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 |

31

1
1
1
1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 2 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 5.00 |
| 2 | 543.00 | 5.00 |

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF .150 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE =-2115.0 PSF

1 A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 150.00 FT.
AND X = 190.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 290.00 FT.
AND X = 360.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -30.0 AND .0

G.

1 FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL
FIRST.

FAILURE SURFACE SPECIFIED BY 16 COORDINATE POINTS



| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 185.56 | 49.42 |
| 2 | 195.55 | 49.27 |
| 3 | 205.55 | 49.60 |
| 4 | 215.51 | 50.43 |
| 5 | 225.43 | 51.74 |
| 6 | 235.27 | 53.53 |
| 7 | 245.01 | 55.80 |
| 8 | 254.62 | 58.54 |
| 9 | 264.10 | 61.74 |
| 10 | 273.40 | 65.41 |
| 11 | 282.51 | 69.52 |
| 12 | 291.42 | 74.08 |
| 13 | 300.09 | 79.06 |
| 14 | 308.50 | 84.46 |
| 15 | 316.65 | 90.26 |
| 16 | 323.74 | 95.85 |

*** F.S.=1.192 ***

| ZOMETRIC URFACE NO. | SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | F |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 100.0 | 100.0 | .0 | $\phi_1$ = 20.0 | .00 | .0 | |
| 1 | 2 | 120.0 | 130.0 | .0 | 30.0 | .00 | .0 | |
| 1 | 3 | 140.0 | 140.0 | .0 | 26.0 | .00 | .0 | |
| 1 | 4 | 140.0 | 140.0 | .0 | 18.0 | .00 | .0 | |
| 1 | 5 | 140.0 | 140.0 | .0 | 18.0 | .00 | .0 | |
| 1 | 6 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | |
| 1 | 7 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | |

1 1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 2 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 5.00 |
| 2 | 543.00 | 5.00 |

1 A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED ALONG THE GROUND SURFACE BETWEEN X = 145.00 FT.
AND X = 190.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 200.00 FT.
AND X = 400.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -30.0 AND .0

G.

1

FOLLOWING ARE ... THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST. 6/E

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 12 COORDINATE POINTS

| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 180.00 | 47.82 |
| 2 | 189.99 | 47.32 |
| 3 | 199.98 | 47.63 |
| 4 | 209.92 | 48.75 |
| 5 | 219.73 | 50.68 |
| 6 | 229.36 | 53.39 |
| 7 | 238.73 | 56.87 |
| 8 | 247.80 | 61.09 |
| 9 | 256.49 | 66.04 |
| 10 | 264.75 | 71.67 |
| 11 | 272.53 | 77.96 |
| 12 | 273.26 | 78.65 |

*** F.S. = 1.165 ***

| SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | ZOMETRIC URFACE NO. |
|---|---|---|---|---|---|---|---|
| 1 | 100.0 | 100.0 | .0 | $\Phi_1 =$ 30.0 | .00 | .0 | 1 |
| 2 | 120.0 | 130.0 | .0 | 30.0 | .00 | .0 | 1 |
| 3 | 140.0 | 140.0 | .0 | 26.0 | .00 | .0 | 1 |
| 4 | 140.0 | 140.0 | .0 | 18.0 | .00 | .0 | 1 |
| 5 | 140.0 | 140.0 | .0 | 18.0 | .00 | .0 | 1 |
| 6 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | 1 |
| 7 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | 1 |

1 1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 2 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 5.00 |
| 2 | 543.00 | 5.00 |

1 A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED ALONG THE GROUND SURFACE BETWEEN X = 80.00 FT.
AND X = 170.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 250.00 FT.
AND X = 340.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION. THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -30.0 AND .0

G.

1 FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 150.00 | 40.04 |
| 2 | 160.00 | 39.90 |
| 3 | 170.00 | 40.12 |
| 4 | 179.98 | 40.70 |
| 5 | 189.94 | 41.64 |
| 6 | 199.85 | 42.93 |
| 7 | 209.72 | 44.58 |
| 8 | 219.51 | 46.58 |
| 9 | 229.23 | 48.92 |
| 10 | 238.86 | 51.62 |
| 11 | 248.39 | 54.66 |
| 12 | 257.80 | 58.04 |
| 13 | 267.09 | 61.75 |
| 14 | 276.24 | 65.79 |
| 15 | 285.23 | 70.16 |
| 16 | 294.06 | 74.85 |
| 17 | 302.72 | 79.85 |
| 18 | 311.20 | 85.16 |
| 19 | 319.48 | 90.76 |
| 20 | 327.55 | 96.66 |
| 21 | 328.65 | 97.53 |

*** F.S. = 1.822 ***

ITEM 5

STABILITY ANALYSIS OF CUT SLOPES

(0655B-6)

PROBLEM STATEMENT

DETERMINE THE FACTOR OF SAFETY FOR CRITICAL CUT SLOPES IN THE NATURAL MATERIAL ABUTTING LANDFILL 1 AND 2.

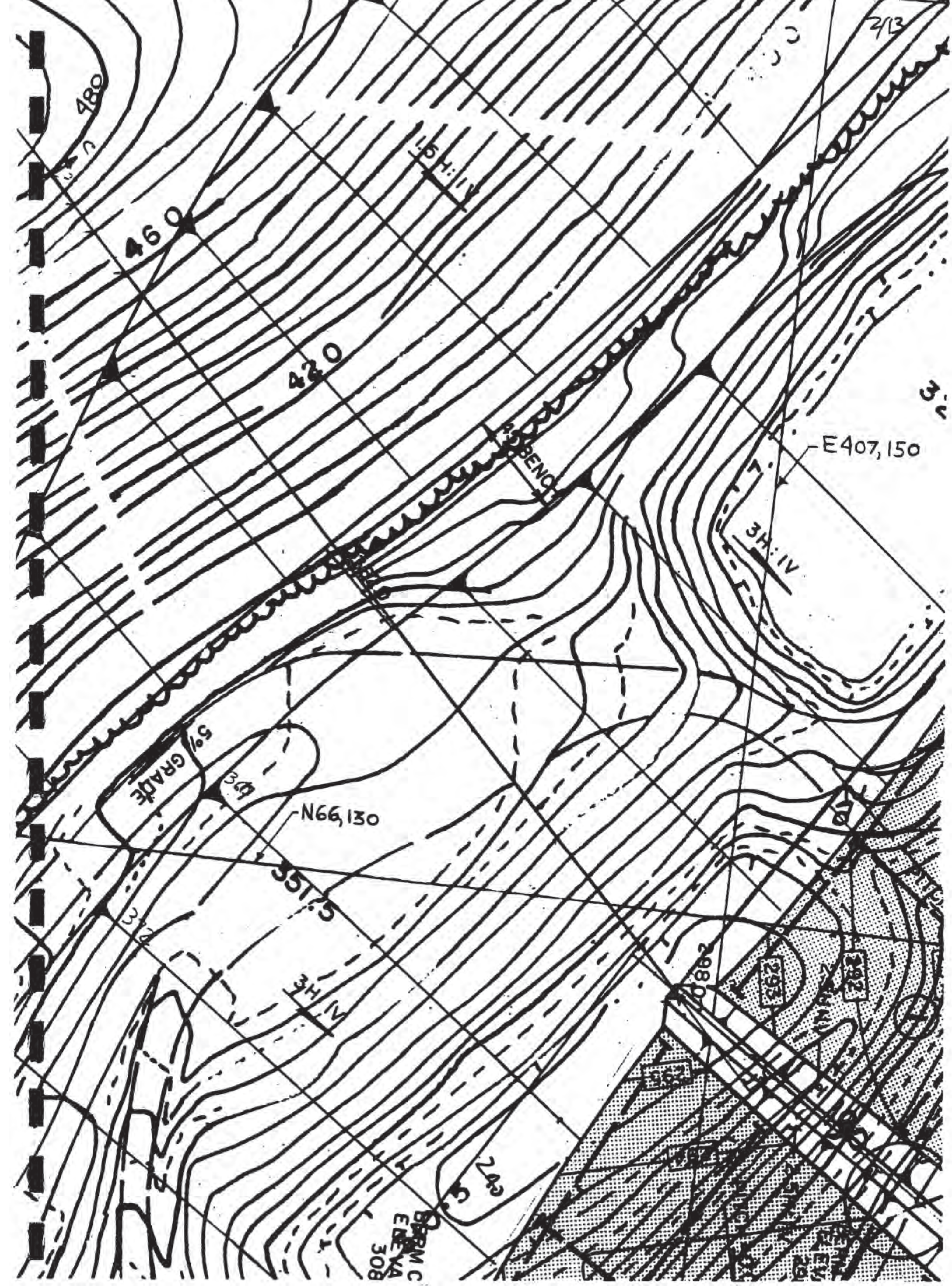
ASSUMPTIONS

- INSPECTION OF CUTS AROUND LANDFILLS 1 AND 2 SHOWS THAT THE PROBABLE CRITICAL FAILURE SLOPE IS LOCATED AT LANDFILL 2. THE SLOPE IS A 1.5H/1V SLOPE DEFINING THE EAST SIDE OF THE PERIMETER BERM AS SHOWN BY SECTION C-C ON THE FOLLOWING PAGE. (REFERENCE DRAWING No. BS11E-L16)
- FOR THE PURPOSE OF SIMPLIFYING ANALYSIS, TWO SOIL TYPES ARE USED. THE FOLLOWING EFFECTIVE STRESS PARAMETERS ARE USED: SOIL 1 - UNIT WT. OF 125 PCF
  - COHESION OF 2000 PSF
  - FRICTION ANGLE OF 20°

  SOIL 2 - UNIT WT. OF 140 PCF
  - COHESION OF 2000 PSF
  - FRICTION ANGLE OF 35°

  PARAMETERS FOR SOIL 1 ARE APPROXIMATE AND ARE TYPICAL FOR INORGANIC CLAYS OF HIGH PLASTICITY.[1] PARAMETERS FOR SOIL 2 ARE APPROXIMATE. BORING LOGS SHOW THAT SOIL 2 IS ACTUALLY LIMESTONE. (REFERENCE DRAWING No. BS11E - UNNUMBERED) SOIL 2 PARAMETERS ARE THEREFORE HIGH SINCE POTENTIAL CRITICAL FAILURE SURFACES WILL NOT PASS THROUGH IT.
- LIQUEFACTION POTENTIAL AT THE SITE IS NOT CONSIDERED SINCE THE WATER TABLE IS WELL BELOW THE POTENTIAL CRITICAL FAILURE SURFACE AND BECAUSE CLAY IS NOT SUSCEPTIBLE TO LIQUEFACTION PHENOMENA.

[1] NAVFAC DM-7, TABLE 9-1


480
460
420
E407,150
3H:1V
5% GRADE
N66,130
351.5
3H:1V
293
292
240

3/13

# TABLE 9-1
## Typical Properties of Compacted Materials

| Group symbol | Soil type | Range of maximum dry unit weight, pcf | Range of optimum moisture, percent | Typical value of compression: At 1.4 tsf (20 psi), percent of original height | Typical value of compression: At 3.6 tsf (50 psi), percent of original height | Typical strength characteristics: Cohesion (as compacted) psf | Typical strength characteristics: Cohesion (saturated) psf | Typical strength characteristics: φ(Effective stress envelope) degrees | Typical strength characteristics: Tan φ | Typical coefficient of permeability ft/min. | Range of CBR values | Range of subgrade modulus k lb/cu in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Well graded clean gravels, gravel-sand mixtures. | 125 - 135 | 11 - 8 | 0.3 | 0.6 | 0 | 0 | >38 | >0.79 | $5 \times 10^{-2}$ | 40 - 80 | 300 - 500 |
| GP | Poorly graded clean gravels, gravel-sand mix. | 115 - 125 | 14 - 11 | 0.4 | 0.9 | 0 | 0 | >37 | >0.74 | $10^{-1}$ | 30 - 60 | 250 - 400 |
| GM | Silty gravels, poorly graded gravel-sand-silt. | 120 - 135 | 12 - 8 | 0.5 | 1.1 | ........ | ........ | >34 | >0.67 | $>10^{-6}$ | 20 - 60 | 100 - 400 |
| GC | Clayey gravels, poorly graded gravel-sand-clay. | 115 - 130 | 14 - 9 | 0.7 | 1.6 | ........ | ........ | >31 | >0.60 | $>10^{-7}$ | 20 - 40 | 100 - 300 |
| SW | Well graded clean sands, gravelly sands. | 110 - 130 | 16 - 9 | 0.6 | 1.2 | 0 | 0 | 38 | 0.79 | $>10^{-3}$ | 20 - 40 | 200 - 300 |
| SP | Poorly graded clean sands, sand-gravel mix. | 100 - 120 | 21 - 12 | 0.8 | 1.4 | 0 | 0 | 37 | 0.74 | $>10^{-3}$ | 10 - 40 | 200 - 300 |
| SM | Silty sands, poorly graded sand-silt mix. | 110 - 125 | 16 - 11 | 0.8 | 1.6 | 1050 | 420 | 34 | 0.67 | $5 \times 10^{-5}$ | 10 - 40 | 100 - 300 |
| SM-SC | Sand-silt clay mix with slightly plastic fines. | 110 - 130 | 15 - 11 | 0.8 | 1.4 | 1050 | 300 | 33 | 0.66 | $2 \times 10^{-6}$ | ........ | |
| SC | Clayey sands, poorly graded sand-clay mix. | 105 - 125 | 19 - 11 | 1.1 | 2.2 | 1550 | 230 | 31 | 0.60 | $5 \times 10^{-7}$ | 5 - 20 | 100 - 300 |
| ML | Inorganic silts and clayey silts . | 95 - 120 | 24 - 12 | 0.9 | 1.7 | 1400 | 190 | 32 | 0.62 | $10^{-5}$ | 15 or less | 100 - 200 |
| ML-CL | Mixture of inorganic silt and clay | 100 - 120 | 22 - 12 | 1.0 | 2.2 | 1350 | 460 | 32 | 0.62 | $5 \times 10^{-7}$ | ........ | |
| CL | Inorganic clays of low to med. plasticity. | 95 - 120 | 24 - 12 | 1.3 | 2.5 | 1800 | 270 | 28 | 0.54 | $10^{-7}$ | 15 or less | 50 - 200 |
| OL | Organic silts and silt-clays, low plasticity. | 80 - 100 | 33 - 21 | ........ | ........ | ........ | ........ | ........ | ..... | ........ | 5 or less | 50 - 100 |
| MH | Inorganic clayey silts, elastic silts. | 70 - 95 | 40 - 24 | 2.0 | 3.8 | 1500 | 420 | 25 | 0.47 | $5 \times 10^{-7}$ | 10 or less | 50 - 100 |
| * CH | Inorganic clays of high plasticity | 75 - 105 | 36 - 19 | 2.6 | 3.9 | $\boxed{2150}$ | 230 | $\boxed{19}$ | 0.35 | $10^{-7}$ | 15 or less | 50 - 150 |
| OH | Organic clays and silty clays . . . | 65 - 100 | 45 - 21 | ........ | ........ | ........ | ........ | ........ | ..... | ........ | 5 or less | 25 - 100 |

Notes:
1. All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown. (....) indicates insufficient data available for an estimate.

* USE C ≈ 2000PSF φ = 20°

| BY RCM DATE 1/31/86 CHK'D BMM DATE 2/11/86 | FRED C. HART ASSOCIATES, INC. | SHEET 4 OF 13 PAGE |
|---|---|---|

SUBJECT PROTECO JOB NO. 8511E

SLOPE STABILITY ANALYSIS

ANALYSIS

THE SLOPE STABILITY FACTOR OF SAFETY AGAINST SLIDING WAS CALCULATED USING THE 'STABL3' COMPUTER PROGRAM. STABL3 ANALYZED FAILURE SURFACES BY THE SIMPLIFIED JANBU METHOD.

- EARTHQUAKE LOADING
  - STABL3 PLACES A PSEUDO-STATIC LOAD ON THE SOIL BASED ON SEISMIC COEFFICIENTS.
  - USING FIGURE A-3 (SEISMIC ZONE MAP OF THE CONTIGUOUS STATES AND PUERTO RICO)[2], WITH PUERTO RICO IN ZONE 3, A SEISMIC COEFFICIENT OF 0.15 IS SPECIFIED.
  - CAVITATION PRESSURE = -2115 PSF[3] FOR GRANULAR SOILS. THE POTENTIAL CRITICAL FAILURE SURFACE IS IN A COHESIVE SOIL. HOWEVER, CAVITATION PRESSURE IS NOT AS CRITICAL IN COHESIVE SOILS DUE TO THE PORE SIZE. ALSO, THE WATER TABLE IS WELL BELOW THE POTENTIAL CRITICAL FAILURE SURFACE.

RESULTS

POTENTIAL CRITICAL FAILURE SURFACES ARE SHOWN IN FIGURE 1. A SEISMIC COEFF. OF 0.20 WAS USED IN THE ANALYSIS INSTEAD OF 0.15 (CONSERVATIVE). COMPUTER OUTPUT IS GIVEN IN PAGES A1 THROUGH C3.

CONCLUSIONS

THE CALCULATED FACTORS OF SAFETY FOR THE MOST CRITICAL POTENTIAL FAILURE SURFACES ARE ABOVE THE GENERALLY ACCEPTED VALUE OF 1.5 (STATIC) AND 1.2 (EARTHQUAKE).

[2] ENGINEERING DESIGN AND ANALYSIS FOR CORPS OF ENGINEER PROJECTS ER-1110-2-1806 (16 MAY 1983)

[3] COMPUTER SLOPE STABILITY ANALYSIS FOR INDIANA HIGHWAYS, VOLUME 1, JHRP-77-25

BY RCM DATE 1/29/86 | **FRED C. HART ASSOCIATES, INC.** | SHEET 5 OF 13 | PAGE

CHK'D [signature] DATE 2/11/86

SUBJECT PROTECO JOB NO. BS11E

SLOPE STABILITY ANALYSIS

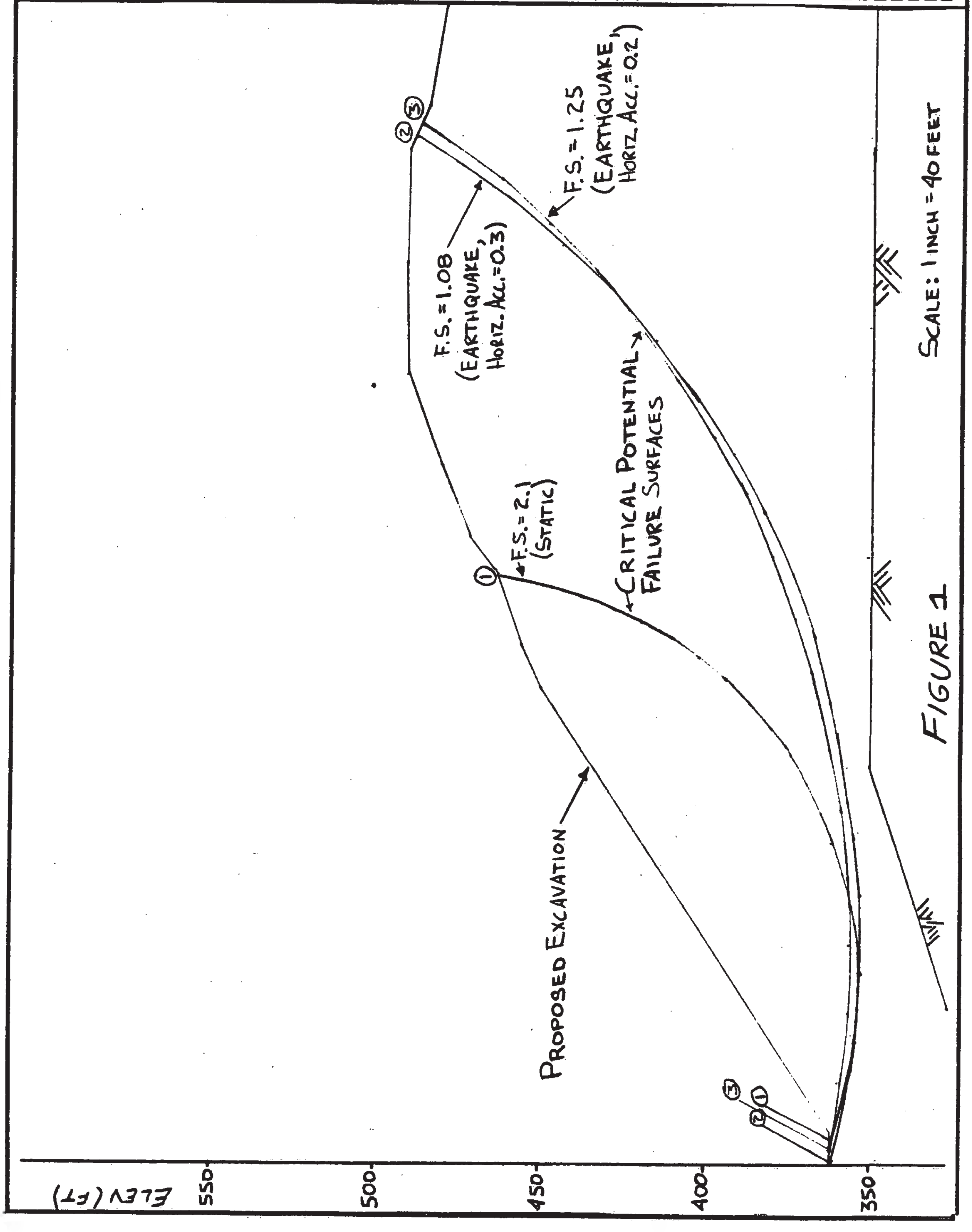



FIGURE 1

APPENDIX D-9.2

STABILIZATION/FIXATION FACILITY

Technical Specifications

This material was previously submitted on January 31, 1986; PROTECO PROJECT MASTER DOCUMENTS LIST - Plans and Specifications.

BOUNDARY COORDINATES

6/13

8 TOP BOUNDARIES
15 TOTAL BOUNDARIES

| BOUNDARY NO. | X-LEFT (FT) | Y-LEFT (FT) | X-RIGHT (FT) | Y-RIGHT (FT) | SOIL TYPE BELOW BND |
|---|---|---|---|---|---|
| 1 | .00 | 295.00 | 50.00 | 295.00 | 1 |
| 2 | 50.00 | 295.00 | 250.00 | 362.00 | 1 |
| 3 | 250.00 | 362.00 | 295.00 | 362.00 | 1 |
| 4 | 295.00 | 362.00 | 427.00 | 450.00 | 1 |
| 5 | 427.00 | 450.00 | 440.00 | 456.00 | 1 |
| 6 | 440.00 | 456.00 | 462.00 | 464.00 | 1 |
| 7 | 462.00 | 464.00 | 472.00 | 472.00 | 1 |
| 8 | 472.00 | 472.00 | 493.00 | 480.00 | 1 |
| 9 | .00 | 100.00 | 52.00 | 100.00 | 2 |
| 10 | 52.00 | 100.00 | 135.00 | 200.00 | 2 |
| 11 | 135.00 | 200.00 | 195.00 | 250.00 | 2 |
| 12 | 195.00 | 250.00 | 256.00 | 300.00 | 2 |
| 13 | 256.00 | 300.00 | 404.00 | 350.00 | 2 |
| 14 | 404.00 | 350.00 | 492.00 | 350.00 | 2 |
| 15 | 492.00 | 350.00 | 493.00 | 350.00 | 2 |

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

| SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | PIE S |
|---|---|---|---|---|---|---|---|
| 1 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | |
| 2 | 140.0 | 140.0 | 2000.0 | 35.0 | .00 | .0 | |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 2 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 210.00 |
| 2 | 135.00 | 210.00 |

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

200 TRIAL SURFACES HAVE BEEN GENERATED.

20 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 280.00 FT

20 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 280.00 FT.
AND X = 300.00 FT.

A2

7/13

EACH SURFACE TERMINATES BETWEEN X = 430.00 FT.
AND X = 460.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -30.0 AND .0 DE

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL
FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 293.33 | 362.00 |
| 2 | 302.74 | 358.61 |
| 3 | 312.40 | 356.01 |
| 4 | 322.24 | 354.22 |
| 5 | 332.19 | 353.24 |
| 6 | 342.19 | 353.09 |
| 7 | 352.16 | 353.76 |
| 8 | 362.05 | 355.25 |
| 9 | 371.78 | 357.55 |
| 10 | 381.29 | 360.64 |
| 11 | 390.51 | 364.51 |
| 12 | 399.39 | 369.13 |
| 13 | 407.85 | 374.46 |
| 14 | 415.84 | 380.47 |
| 15 | 423.31 | 387.12 |
| 16 | 430.20 | 394.36 |
| 17 | 436.48 | 402.15 |
| 18 | 442.09 | 410.42 |
| 19 | 447.00 | 419.14 |
| 20 | 451.17 | 428.22 |
| 21 | 454.59 | 437.62 |
| 22 | 457.21 | 447.27 |
| 23 | 459.03 | 457.10 |
| 24 | 459.64 | 463.14 |

*** F.S.= 2.100 ***

8/13

BOUNDARY COORDINATES

13 TOP BOUNDARIES
24 TOTAL BOUNDARIES

| BOUNDARY NO. | X-LEFT (FT) | Y-LEFT (FT) | X-RIGHT (FT) | Y-RIGHT (FT) | SOIL TYPE BELOW BND |
|---|---|---|---|---|---|
| 1 | .00 | 295.00 | 50.00 | 295.00 | 1 |
| 2 | 50.00 | 295.00 | 250.00 | 362.00 | 1 |
| 3 | 250.00 | 362.00 | 295.00 | 362.00 | 1 |
| 4 | 295.00 | 362.00 | 427.00 | 450.00 | 1 |
| 5 | 427.00 | 450.00 | 440.00 | 456.00 | 1 |
| 6 | 440.00 | 456.00 | 462.00 | 464.00 | 1 |
| 7 | 462.00 | 464.00 | 472.00 | 472.00 | 1 |
| 8 | 472.00 | 472.00 | 493.00 | 480.00 | 1 |
| 9 | 493.00 | 480.00 | 520.00 | 491.00 | 1 |
| 10 | 520.00 | 491.00 | 553.00 | 491.00 | 1 |
| 11 | 553.00 | 491.00 | 586.00 | 490.00 | 1 |
| 12 | 586.00 | 490.00 | 600.00 | 485.00 | 1 |
| 13 | 600.00 | 485.00 | 630.00 | 480.00 | 1 |
| 14 | .00 | 100.00 | 52.00 | 100.00 | 2 |
| 15 | 52.00 | 100.00 | 135.00 | 200.00 | 2 |
| 16 | 135.00 | 200.00 | 195.00 | 250.00 | 2 |
| 17 | 195.00 | 250.00 | 256.00 | 300.00 | 2 |
| 18 | 256.00 | 300.00 | 404.00 | 350.00 | 2 |
| 19 | 404.00 | 350.00 | 492.00 | 350.00 | 2 |
| 20 | 492.00 | 350.00 | 493.00 | 350.00 | 2 |
| 21 | 493.00 | 350.00 | 520.00 | 350.00 | 2 |
| 22 | 520.00 | 350.00 | 553.00 | 350.00 | 2 |
| 23 | 553.00 | 350.00 | 586.00 | 350.00 | 2 |
| 24 | 586.00 | 350.00 | 630.00 | 350.00 | 2 |

1

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

| SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | PIEZOMETRIC SURFACE NO. |
|---|---|---|---|---|---|---|---|
| 1 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | 1 |
| 2 | 140.0 | 140.0 | 2000.0 | 35.0 | .00 | .0 | 1 |

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 2 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 210.00 |
| 2 | 135.00 | 210.00 |

|  |  |  |
|---|---|---|
|  | .00 | 210.00 |
| 2 | 135.00 | 210.00 |

B2

9/13

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF .300 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE =-2115.0 PSF

1 A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

20 SURFACES INITIATE FROM EACH OF 5 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 265.00 FT.
AND X = 285.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 590.00 FT.
AND X = 620.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -30.0 AND .0 D
G.

1 FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL
FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 37 COORDINATE POINTS

| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 285.00 | 362.00 |
| 2 | 294.71 | 359.62 |
| 3 | 304.50 | 357.59 |
| 4 | 314.36 | 355.92 |
| 5 | 324.28 | 354.61 |
| 6 | 334.23 | 353.66 |
| 7 | 344.22 | 353.08 |
| 8 | 354.21 | 352.87 |
| 9 | 364.21 | 353.02 |
| 10 | 374.20 | 353.53 |
| 11 | 384.16 | 354.41 |

FAILURE SURFACE SPECIFIED BY 37 COORDINATE POINTS



| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 285.00 | 362.00 |
| 2 | 294.71 | 359.62 |
| 3 | 304.50 | 357.59 |
| 4 | 314.36 | 355.92 |
| 5 | 324.28 | 354.61 |
| 6 | 334.23 | 353.66 |
| 7 | 344.22 | 353.08 |
| 8 | 354.21 | 352.87 |
| 9 | 364.21 | 353.02 |
| 10 | 374.20 | 353.53 |
| 11 | 384.16 | 354.41 |
| 12 | 394.08 | 355.65 |
| 13 | 403.95 | 357.25 |
| 14 | 413.76 | 359.21 |
| 15 | 423.49 | 361.53 |
| 16 | 433.12 | 364.20 |
| 17 | 442.66 | 367.23 |
| 18 | 452.07 | 370.60 |
| 19 | 461.36 | 374.30 |
| 20 | 470.50 | 378.35 |
| 21 | 479.49 | 382.73 |
| 22 | 488.32 | 387.43 |
| 23 | 496.97 | 392.45 |
| 24 | 505.42 | 397.79 |
| 25 | 513.68 | 403.43 |
| 26 | 521.73 | 409.36 |
| 27 | 529.55 | 415.59 |
| 28 | 537.15 | 422.10 |
| 29 | 544.50 | 428.88 |
| 30 | 551.59 | 435.93 |
| 31 | 558.43 | 443.23 |
| 32 | 564.99 | 450.77 |
| 33 | 571.27 | 458.55 |
| 34 | 577.27 | 466.55 |
| 35 | 582.97 | 474.77 |
| 36 | 588.37 | 483.19 |
| 37 | 591.27 | 488.12 |

1

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

11/13

PROBLEM DESCRIPTION BERM

BOUNDARY COORDINATES

13 TOP BOUNDARIES
24 TOTAL BOUNDARIES

| BOUNDARY NO. | X-LEFT (FT) | Y-LEFT (FT) | X-RIGHT (FT) | Y-RIGHT (FT) | SOIL TYPE BELOW BND |
|---|---|---|---|---|---|
| 1 | .00 | 295.00 | 50.00 | 295.00 | 1 |
| 2 | 50.00 | 295.00 | 250.00 | 362.00 | 1 |
| 3 | 250.00 | 362.00 | 295.00 | 362.00 | 1 |
| 4 | 295.00 | 362.00 | 427.00 | 450.00 | 1 |
| 5 | 427.00 | 450.00 | 440.00 | 456.00 | 1 |
| 6 | 440.00 | 456.00 | 462.00 | 464.00 | 1 |
| 7 | 462.00 | 464.00 | 472.00 | 472.00 | 1 |
| 8 | 472.00 | 472.00 | 493.00 | 480.00 | 1 |
| 9 | 493.00 | 480.00 | 520.00 | 491.00 | 1 |
| 10 | 520.00 | 491.00 | 553.00 | 491.00 | 1 |
| 11 | 553.00 | 491.00 | 586.00 | 490.00 | 1 |
| 12 | 586.00 | 490.00 | 600.00 | 485.00 | 1 |
| 13 | 600.00 | 485.00 | 630.00 | 480.00 | 1 |
| 14 | .00 | 100.00 | 52.00 | 100.00 | 2 |
| 15 | 52.00 | 100.00 | 135.00 | 200.00 | 2 |
| 16 | 135.00 | 200.00 | 195.00 | 250.00 | 2 |
| 17 | 195.00 | 250.00 | 256.00 | 300.00 | 2 |
| 18 | 256,00 | 300.00 | 404.00 | 350.00 | 2 |
| 19 | 404.00 | 350.00 | 492.00 | 350.00 | 2 |
| 20 | 492.00 | 350.00 | 493.00 | 350.00 | 2 |
| 21 | 493.00 | 350.00 | 520.00 | 350.00 | 2 |
| 22 | 520.00 | 350.00 | 553.00 | 350.00 | 2 |
| 23 | 553.00 | 350.00 | 586.00 | 350.00 | 2 |
| 24 | 586.00 | 350.00 | 630.00 | 350.00 | 2 |

1
ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

| SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | PIEZOMETRIC SURFACE NO. |
|---|---|---|---|---|---|---|---|
| 1 | 125.0 | 125.0 | 2000.0 | 20.0 | .00 | .0 | 1 |
| 2 | 140.0 | 140.0 | 2000.0 | 35.0 | .00 | .0 | 1 |

1
1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

1 1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40 12/13

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 2 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 210.00 |
| 2 | 135.00 | 210.00 |

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF .200 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE =-2115.0 PSF

1 A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

140 TRIAL SURFACES HAVE BEEN GENERATED.

20 SURFACES INITIATE FROM EACH OF 7 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 280.00 FT.
AND X = 310.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 570.00 FT.
AND X = 610.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -30.0 AND .0 D
G.

1 FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL
FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 36 COORDINATE POINTS

| POINT | X-SURF | Y-SURF |
|---|---|---|

FAILURE SURFACE SPECIFIED BY 36 COORDINATE POINTS

13/13

| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 290.00 | 362.00 |
| 2 | 299.82 | 360.14 |
| 3 | 309.71 | 358.61 |
| 4 | 319.64 | 357.42 |
| 5 | 329.60 | 356.56 |
| 6 | 339.59 | 356.05 |
| 7 | 349.58 | 355.87 |
| 8 | 359.58 | 356.04 |
| 9 | 369.57 | 356.54 |
| 10 | 379.53 | 357.39 |
| 11 | 389.46 | 358.57 |
| 12 | 399.35 | 360.09 |
| 13 | 409.17 | 361.95 |
| 14 | 418.93 | 364.14 |
| 15 | 428.61 | 366.66 |
| 16 | 438.20 | 369.50 |
| 17 | 447.68 | 372.68 |
| 18 | 457.05 | 376.17 |
| 19 | 466.30 | 379.98 |
| 20 | 475.41 | 384.10 |
| 21 | 484.37 | 388.53 |
| 22 | 493.18 | 393.26 |
| 23 | 501.83 | 398.28 |
| 24 | 510.30 | 403.60 |
| 25 | 518.58 | 409.21 |
| 26 | 526.67 | 415.09 |
| 27 | 534.55 | 421.24 |
| 28 | 542.22 | 427.66 |
| 29 | 549.66 | 434.33 |
| 30 | 556.88 | 441.26 |
| 31 | 563.85 | 448.43 |
| 32 | 570.58 | 455.82 |
| 33 | 577.05 | 463.45 |
| 34 | 583.26 | 471.29 |
| 35 | 589.20 | 479.33 |
| 36 | 594.45 | 486.98 |

*** F.S. = 1.254 ***

ITEM 6

STABILITY ANALYSIS OF COMPACTED

EARTH DIKES

(0655B-7)

BY BMM DATE 2/3/86 | FRED C. HART ASSOCIATES, INC. | SHEET 1 OF 1 PAGE

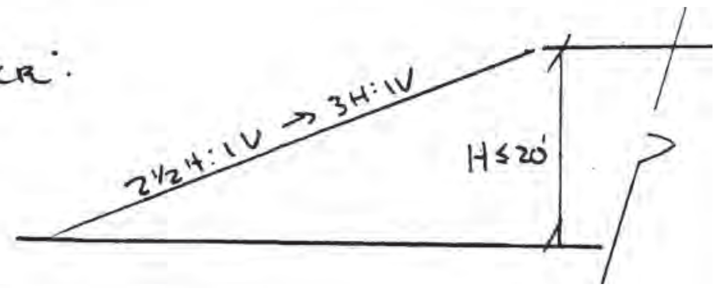
CHK'D RCM DATE 2/4/86

SUBJECT Stability Evaluation – Proteco Compacted Earth Dike JOB NO.

Check Stability of Typical Compacted Earth Dike (Interim Berm) via Taylor's Charts

Ref: Fundamentals of Soil Mechanics; Taylor, 13rd, Dec 1963 p. 459.

Typical Dike:




From Avg. Lab Data

$\phi = 10^\circ$

$C = 830$ psf

$\gamma \approx 120$ pcf

∴ For $i = \text{ArcTan}\,(2\tfrac{1}{2}H:1V) \approx 22^\circ$

$\phi = 10^\circ$

$C_d/\gamma H = 0.05$

∴ $C_d = \gamma(H)(0.05) = 120(20)(0.05) = 120$ psf

$c_{(avail)} = 830$ psf

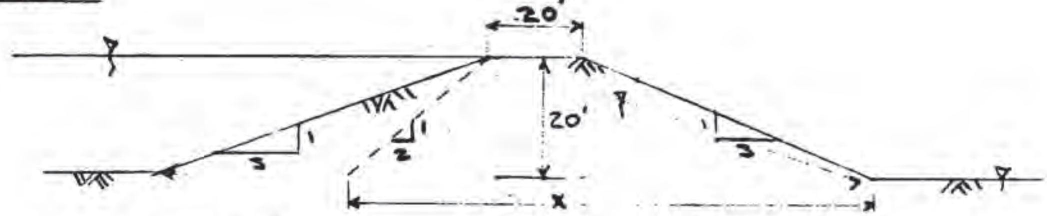
F.C. ≈ $830/120 \cong 7$ ∴ OK

SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. B511
STABILITY ANALYSIS - EARTH DIKE

PROBLEM STATEMENT

CHECK STABILITY OF DIKE.

ASSUMPTIONS




$\phi$ = 3.2 PSF
C 1150 PSF
} TOTAL STRESS VALUES FROM U-U TEST ON REG. CLAY

$\gamma$ = 120 PSF $\quad e = 0.6 \rightarrow n = \frac{e}{1+e} = .375$

$\gamma_{SAT}$ = 125 PSF

CONSIDER THE MOST CRITICAL CASE. (SHOWN ABOVE WITH AN APPROXIMATE PHREATIC SURFACE)

SOLUTION

- CALCULATE TIME FOR PHREATIC SURFACE (SHOWN ABOVE) TO DEVELOP.

$T = kt/n_e h$

where $k$ = coef. of permeability $\approx 1 \times 10^{-7}$ CM/s (CLAY)

$\approx 3.28 \times 10^{-9}$ FT/s $\approx .104$ FT/YR

$n_e$ = effective porosity = .375

$h$ = 20 FT

$t$ = time (YR)

$X = 20 + 3/1(20) + 2/1(20) = 120$ FT (DISTANCE TO TOE)

$X/h = 120/20 = 6$

FIGURE 2 $\rightarrow T = 10.0$

$t = Tn_e h/k$

$t = 10(.375)(20)/.104$

$t$ = 721 YEARS

SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. 8511
STABILITY ANALYSIS - EARTH DIKE

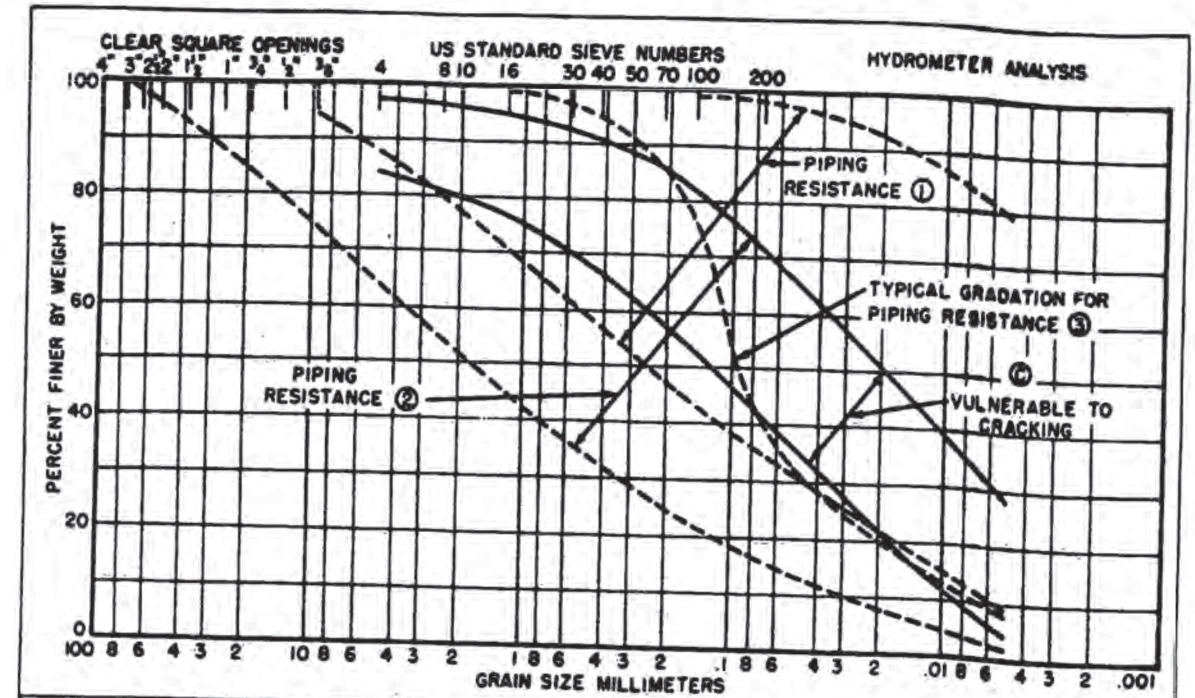
| | |
|---|---|
| $k = 1\times10^{-6}$ cm/s ≈ 1.04 FT/YR | $k = 1\times10^{-5}$ cm/s = 10.35 FT/YR |
| $x/h = 6$ | $x/h = 6$ |
| FIGURE 2 → T = 10.0 | FIGURE 2 → T = 10.0 |
| $t = T n_e h / k$ = 72 YEARS | t = 7.2 YEARS |

- CALCULATE SLOPE STABILITY UNDER EARTHQUAKE CONDITIONS. SEE ATTACHED STABL3 OUTPUT.

CONCLUSIONS

- A FACTOR OF SAFETY OF 1.80 WAS OBTAINED FOR THE POTENTIAL CRITICAL FAILURE SURFACE. THE FACTOR OF SAFETY EXCEEDS THE RECOMMENDED VALUE OF 1.1 AND IS THEREFORE ACCEPTABLE.
- IT WOULD TAKE OVER 700 YEARS FOR THE PHREATIC SURFACE TO REACH THE TOE ON THE OUTSIDE OF THE DIKE WITH $K = 1\times10^{-7}$ CM/SEC. AN INCREASE IN THE COEFFICIENT OF PERMEABILITY OF THE CLAY TO $1\times10^{-5}$ CM/SEC WOULD RESULT IN A TIME OF 7.2 YEARS FOR THE ASSUMED PHREATIC SURFACE TO REACH THE TOE. THUS, LEACHATE PASSING THROUGH THE DIKE WOULD TAKE A CONSIDERABLE AMOUNT OF TIME. NOTE THAT THE DIKE IS LINED WITH HDPE AND THAT MANHOLES ARE PLACED IN THE BERM IN ORDER TO DETECT LEACHATE.

# TABLE 9-2
## Resistance of Earth Dam Embankment Materials to Piping and Cracking




| Category | Material | Characteristics |
|---|---|---|
| **Piping resistance:** | | |
| ① | CL and CH with PI > 15, well graded SC with PI > 15. | Greatest resistance to piping, small and medium concentrated leaks will heal themselves. Embankment may fail as a result of slowly progressive piping caused by leak of about 1/2 cfs. |
| ② | CL and ML with PI < 15, well graded SC and GC with 15 > $\bar{P}$I > 7. | Intermediate resistance to piping. Safely resists saturation of lower portion of downstream slope indefinitely. May fail eventually as a result of erosion caused by a small concentrated leak or by progressive sloughing. If a large leak develops, piping causes failure in a short time. |
| ③ | SP and uniform SM and ML with PI < 7. | Least resistance to piping. Usually fails in a few years after first reservoir filling if seepage is able to break out on downstream slope. Small concentrated leak on downstream slope can cause failure in a short period of time. High density from compaction increases resistance significantly. |
| **Cracking resistance:** | | |
| Ⓐ | CH with $D_{50} < 0.02$mm and PI > 20. | High postconstruction settlement, particularly if compacted dry. Has sufficient deformability to undergo large shear strains from differential settlement without cracking. |
| Ⓑ | GC, SC, SM, SP with $D_{50} > 0.15$mm. | Small postconstruction settlement. Little chance for cracking unless poorly compacted and large settlement is imposed on embankment by consolidation of the foundation. |
| Ⓒ | CL, ML and SM with PI < 20, $0.15\text{ mm} > D_{50} > 0.02\text{ mm}$. | Medium to high postconstruction settlement and vulnerable to cracking. Should be compacted as wet as possible consistent with strength requirements. |

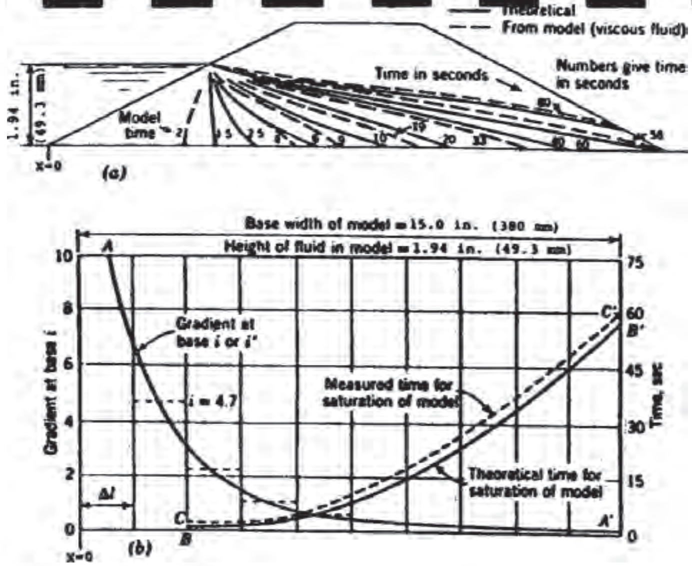



**FIG. 1.—Comparison of Phreatic Surfaces between Theory and Model: (a) Progress of Phreatic Surface; (b) Hydraulic Gradient and Time for Saturation at Base**

The time required for a phreatic surface to advance a given distance along the base can be determined by

$$\Delta t = \frac{\Delta l}{v_s} \quad (1)$$

in which $\Delta t$ = time increment; $\Delta l$ = incremental distance traveled; and $v_s$ = seepage velocity. According to Darcy's law

$$v_s = \frac{ki}{n_e} \quad (2)$$

in which $k$ = coefficient of permeability; $i$ = hydraulic gradient; and $n_e$ = effective porosity, which includes the air void but not the water that cannot be drained. Substituting Eq. 2 into Eq. 1

$$\Delta t = \frac{n_e \Delta l}{ki} \quad (3)$$

Because the hydraulic gradient is not uniform along the base, the distance $x$ traveled must be divided into a number of equal increments, $\Delta l$, as shown in Fig. 1(*b*). For each increment, the average hydraulic gradient is determined from line AA'. The time required to advance a given distance $x$, as indicated by line BB' can be determined by

$$t = \Sigma \Delta t = \sum \frac{n_e \Delta l}{ki} = \frac{n_e \Delta l}{k} \sum \frac{1}{i} \quad (4)$$



**TABLE 1.—Time-Distance Relationship**

| $x/\Delta l$ (1) | $x/h$ (2) | $t$ (sec) (3) | $T$ (4) |
|---|---|---|---|
| 1 | 0.77 | 0.22 | 0.07 |
| 2 | 1.54 | 0.73 | 0.24 |
| 3 | 2.31 | 1.80 | 0.59 |
| 4 | 3.08 | 3.96 | 1.29 |
| 5 | 3.85 | 8.27 | 2.70 |
| 6 | 4.62 | 14.5 | 4.73 |
| 7 | 5.39 | 23.3 | 7.60 |
| 8 | 6.16 | 34.0 | 11.1 |
| 9 | 6.93 | 45.0 | 14.7 |
| 10 | 7.70 | 56.9 | 18.5 |

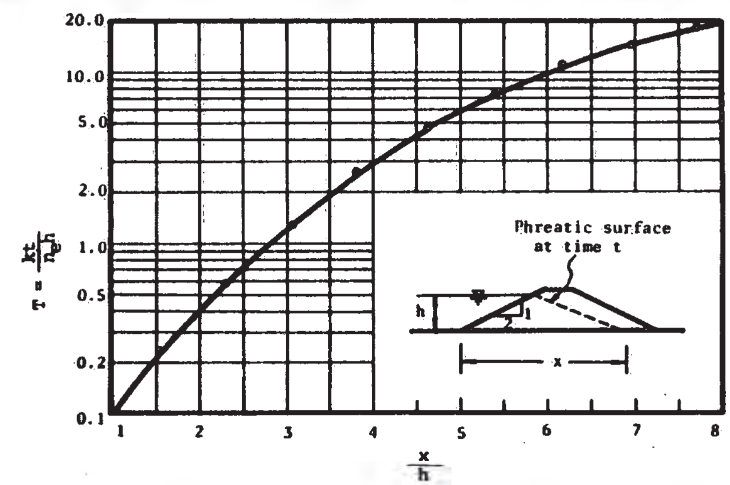



**FIG. 2.—Relationship between Dimensionless Time and Dimensionless Distance**

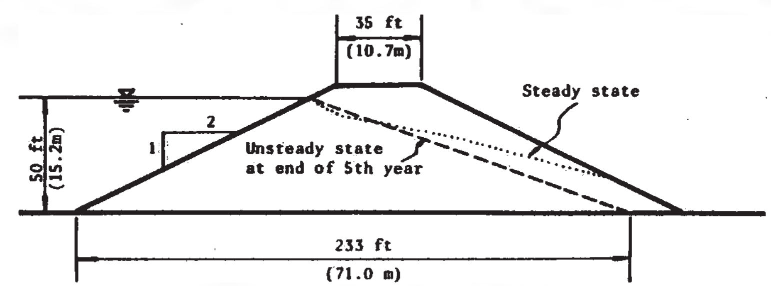



**FIG. 3.—Location of Phreatic Surface**



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in which $i$ = the average hydraulic gradient for each increment.

Line BB', which is based on a pool depth, $h$, of 1.94 in. (49.3 mm) and given values of $n_e$ and $k$, can be applied to other values of $h$, $n_e$, and $k$, as long as the upstream slope is 2:1 (horizontal to vertical). This can be achieved by changing $\Delta l$ and $t$ to dimensionless terms by converting Eq. 4 to

$$T = \frac{kt}{n_e h} = \frac{\Delta l}{h} \sum \frac{1}{i} \quad \text{(5)}$$

in which $T$ = dimensionless time; and $\Delta l/h$ = dimensionless increment. To convert $t$ into $T$, it is necessary to know $k/n_e$. The hydraulic gradients at the six intervals of $\Delta l$, as measured from line AA', are 10.7, 4.7, 2.2, 1.1, 0.55, and 0.38, respectively. From Eq. 4 with $t$ = 14.5 sec, as obtained from line BB', and $\Delta l$ = 1.5 in. (38 mm), $n_e/k = 14.5/[1.5(1/10.7 + 1/4.7 + 1/2.2 + 1/1.1 + 1/0.55 + 1/0.38)] = 1.58$ sec/in. (0.062 sec/mm). Due to the difficulty of measuring the time accurately from line BB', Eq. 4 was used to determine the time when $t < 14.5$ sec. When $t \geq 14.5$, the time was measured from line BB'. The time-distance relationship is shown in Table 1. Note that $x/h$ are obtained from $x/\Delta l$ and $T$ from $t$ by

$$\frac{x}{h} = \frac{\Delta l}{h}\frac{x}{\Delta l} = 0.77\frac{x}{\Delta l} \quad \text{(6)}$$

$$T = \frac{kt}{n_e h} = \frac{t}{1.58 \times 1.94} = 0.326t \quad \text{(7)}$$

Fig. 2 is a plot of dimensionless time, $T$, versus dimensionless distance, $x/h$. At any given time, $t$, the distance $x$ can be determined from Fig. 2 and the phreatic surface located. It should be pointed out that Fig. 2 is valid only with cases involving an upstream slope of 2:1 and a horizontal impervious base. However, it can be applied to other cases with conservative results, as will be examined later.

## Example

Fig. 3 shows a temporary dam with a horizontal impervious base. The soil in the dam has a permeability of $3 \times 10^{-7}$ ft/sec ($2.7 \times 10^{-5}$ cm/s) and an effective porosity of 0.2. If the dam is used for only five years, determine the location of the unsteady state phreatic surface at the end of the 5th year. Given $t$ = 5 yrs, $k = 3 \times 10^{-7}$ ft/sec = 9.5 ft/yr; $n_e$ = 0.2 and $h$ = 50 ft; $T = 9.5 \times 5/(0.2 \times 50) = 4.75$. From Fig. 2, $x/h$ = 4.66, or $x = 4.66 \times 50 = 233$ ft (71.0 m). The location of the phreatic surface at the end of the 5th year is shown in Fig. 3 by the dashed line.

It will be interesting to see how the design life affects the safety factor of the dam. If the dam is permanent, the phreatic surface will finally become steady state, as indicated by the dotted line. By assuming that the soil has an effective cohesion of 200 psf (9.6 kN/m$^2$), an effective friction angle of 30°, and a mass unit weight of 125 pcf (19.6 kN/m$^3$), the factor of safety obtained by the REAME computer program (2) based



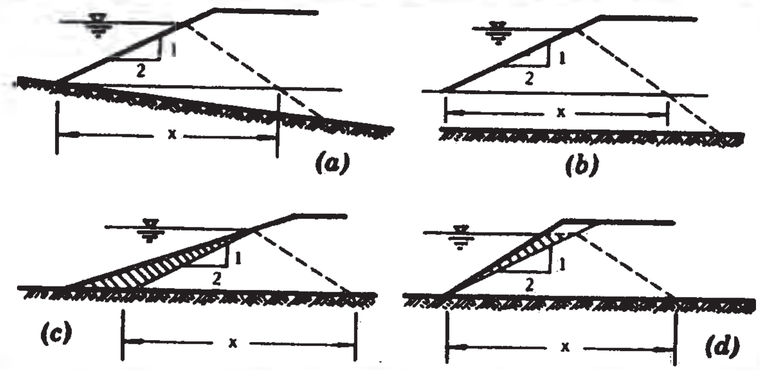



**FIG. 4.—Applications to Special Cases: (*a*) Sloping Base; (*b*) Soil Foundation; (*c*) Flatter Slope; (*d*) Steeper Slope**

on the simplified Bishop method and the steady state phreatic surface is only 1.178. If the unsteady state phreatic surface is used, the factor of safety is 1.544.

## Analysis

The method presented is based on the results obtained by Cedergren for dams with a horizontal impervious base and an upstream slope of 2:1. For dams with other configurations, the procedures shown in Fig. 4 can be used. If the impervious base is not horizontal or the dam is placed on a soil foundation, an imaginary horizontal base is assumed and the method applied as usual. The extra flow region below the imaginary base will lower the phreatic surface, so the assumption of a horizontal base is on the safe side. If the slope is flatter than 2:1, a 2:1 slope is drawn from the pool elevation; if the slope is steeper than 2:1, a 2:1 slope is drawn from the toe. In both cases, the hatched portion of the dam is considered as water instead of soil, and the method is applied as usual. The replacement of soil by water will cause the phreatic surface to rise and is therefore on the safe side.

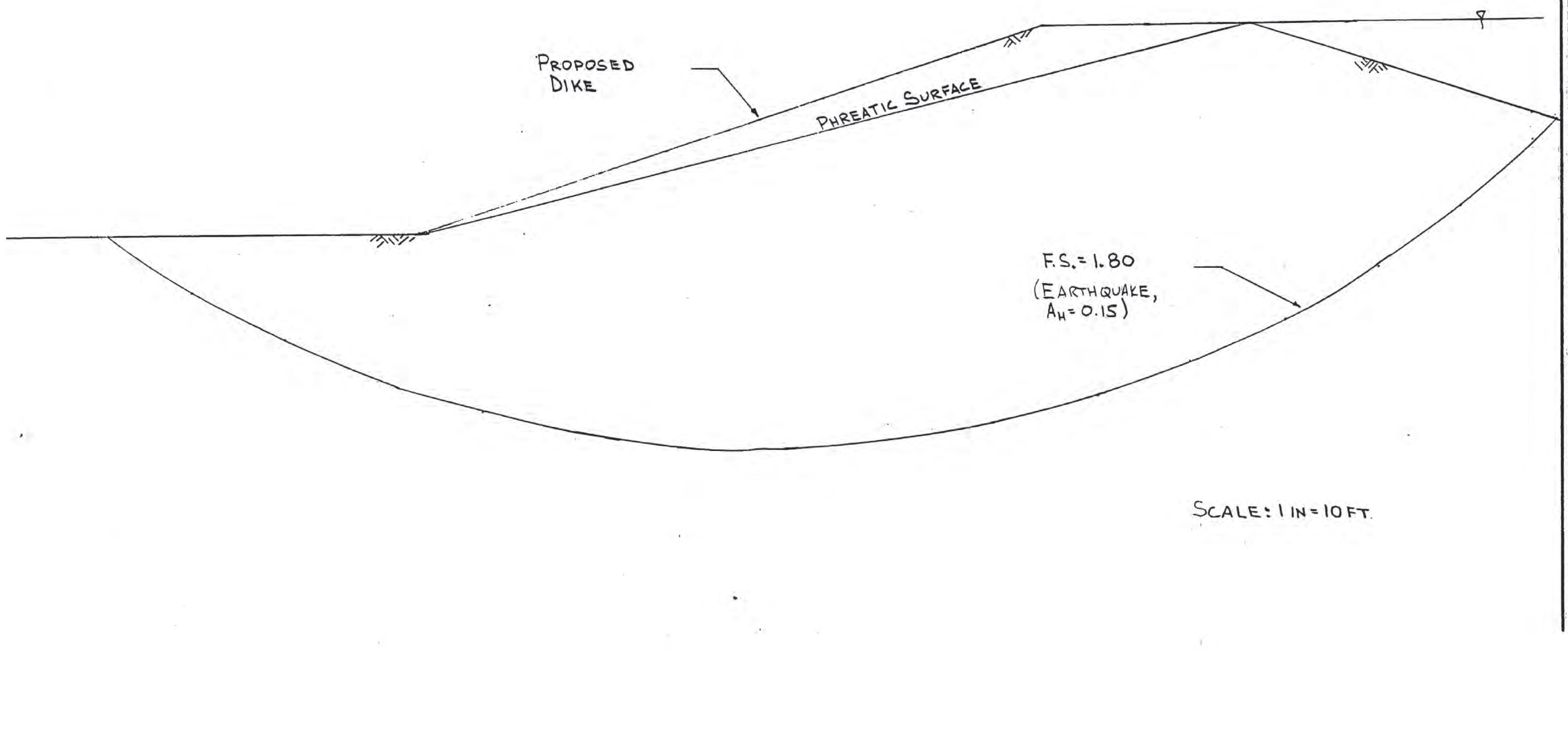
In the development of Fig. 2, the value of $n_e/k$ used for obtaining line BB' in Fig. 1 must be determined. Although a great care has been exercised in measuring the hydraulic gradients from line AA', the value of $n_e/k$ may not be very accurate. However, even if $n_e/k$ or Fig. 1 is not accurate, the procedure for extending Fig. 1 to Fig. 2 is still valid and can be applied once more accurate solutions are obtained.

## Summary

A simple method was developed for estimating the unsteady state phreatic surface in earth dams as a function of time. The method is useful in the steady state analysis of temporary earth dams where the steady state phreatic surface may not develop during the life span of the dams. Although the method is based on transient flownets and yields only approximate results, the uncertainty in determining the permeability and



98


PROPOSED DIKE
PHREATIC SURFACE
F.S. = 1.80
(EARTHQUAKE, $A_H$ = 0.15)
SCALE: 1 IN = 10 FT.

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PROBLEM DESCRIPTION BASIN

BOUNDARY COORDINATES

5 TOP BOUNDARIES
5 TOTAL BOUNDARIES

| BOUNDARY NO. | X-LEFT (FT) | Y-LEFT (FT) | X-RIGHT (FT) | Y-RIGHT (FT) | SOIL TYPE BELOW BND |
|---|---|---|---|---|---|
| 1 | .00 | 40.00 | 200.00 | 40.00 | 1 |
| 2 | 200.00 | 40.00 | 260.00 | 60.00 | 1 |
| 3 | 260.00 | 60.00 | 280.00 | 60.00 | 1 |
| 4 | 280.00 | 60.00 | 340.00 | 40.00 | 1 |
| 5 | 340.00 | 40.00 | 400.00 | 40.00 | 1 |

1 ISOTROPIC SOIL PARAMETERS

1 TYPE(S) OF SOIL

| SOIL TYPE NO. | TOTAL UNIT WT. (PCF) | SATURATED UNIT WT. (PCF) | COHESION INTERCEPT (PSF) | FRICTION ANGLE (DEG) | PORE PRESSURE PARAMETER | PRESSURE CONSTANT (PSF) | PIEZOMETRIC SURFACE NO. |
|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 125.0 | C = 1150.0 | $\phi$ = 3.2 | .00 | .0 | 1 |

1 1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 4 COORDINATE POINTS

| POINT NO. | X-WATER (FT) | Y-WATER (FT) |
|---|---|---|
| 1 | .00 | 40.00 |
| 2 | 200.00 | 40.00 |
| 3 | 280.00 | 60.00 |
| 4 | 400.00 | 60.00 |

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF .150 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF .000 HAS BEEN ASSIGNED

CAVITATION PRESSURE =-2115.0 PSF

1 A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

8/8

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED ALONG THE GROUND SURFACE BETWEEN X = 170.00 FT.
AND X = 230.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 240.00 FT.
AND X = 310.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION. THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -40.0 AND .0 DE
G.

1 FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

| POINT NO. | X-SURF (FT) | Y-SURF (FT) |
|---|---|---|
| 1 | 170.00 | 40.00 |
| 2 | 178.26 | 34.37 |
| 3 | 187.02 | 29.53 |
| 4 | 196.19 | 25.54 |
| 5 | 205.69 | 22.43 |
| 6 | 215.44 | 20.22 |
| 7 | 225.36 | 18.94 |
| 8 | 235.35 | 18.60 |
| 9 | 245.34 | 19.19 |
| 10 | 255.22 | 20.72 |
| 11 | 264.91 | 23.17 |
| 12 | 274.34 | 26.51 |
| 13 | 283.40 | 30.73 |
| 14 | 292.04 | 35.78 |
| 15 | 300.16 | 41.62 |
| 16 | 307.69 | 48.19 |
| 17 | 309.55 | 50.15 |

*** F.S. = 1.802 ***

FAILURE SURFACE SPECIFIED BY 16 COORDINATE POINTS

POINT X-SURF Y-SURF

ITEM 7

EQUIVALENT GEODRAIN/SAND

TRANSMISSIVITY

(0655B-8)

| BY RCM DATE 2/6/86 | FRED C. HART ASSOCIATES, INC. | SHEET 1 OF 2 PAGE |
|---|---|---|
| CHK'D BMM DATE 2/19/86 | | |

SUBJECT: PROTECO - GEOTECHNICAL ANALYSIS — TRANSMISSIVITY

JOB NO. 8511

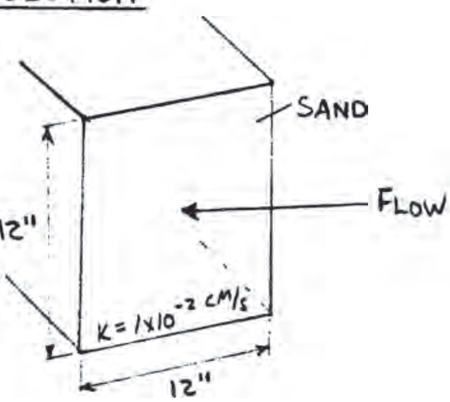
## PROBLEM STATEMENT

DETERMINE IF THE TRANSMISSIVITY OF THE GEONET IS EQUIVALENT TO 12 INCHES OF SAND AT $1 \times 10^{-2}$ CM/SEC

## ASSUMPTIONS

- DETERMINE FOR FLATTEST SLOPE (3H:1V)
- ASSUME 100 FT OF OVERBURDEN AT 100 PSF FOR SOIL/WASTE FILL (CONSERVATIVE)
- USE POLY-NET PN-3000

## SOLUTION




$$Q = k\,i\,A$$

$$Q = 1\times10^{-2}\,\text{CM/S}\left(\frac{\text{IN}}{2.54\,\text{CM}}\right)\underbrace{(.33)}_{i}\overbrace{(12)(12)}^{A}$$

$$Q = 0.192\ \text{IN}^3/\text{SEC}/\text{FT WIDTH}$$

LOAD = 100 FT (100 PCF)

LOAD = 10000 PSF

HYDRAULIC GRADIENT, $i = 1/3 = 0.33$

FROM POLY-NET TRANSMISSIVITY CHART

$$T_{NET} = 4.8\times10^{-4}\ \text{M}^3/\text{S}/\text{M WIDTH}\ \left(\frac{39.37\ \text{IN}}{\text{M}}\right)^3\left(\frac{\text{M}}{39.37\ \text{IN}}\right)\left(\frac{12\ \text{IN}}{\text{FT}}\right)$$

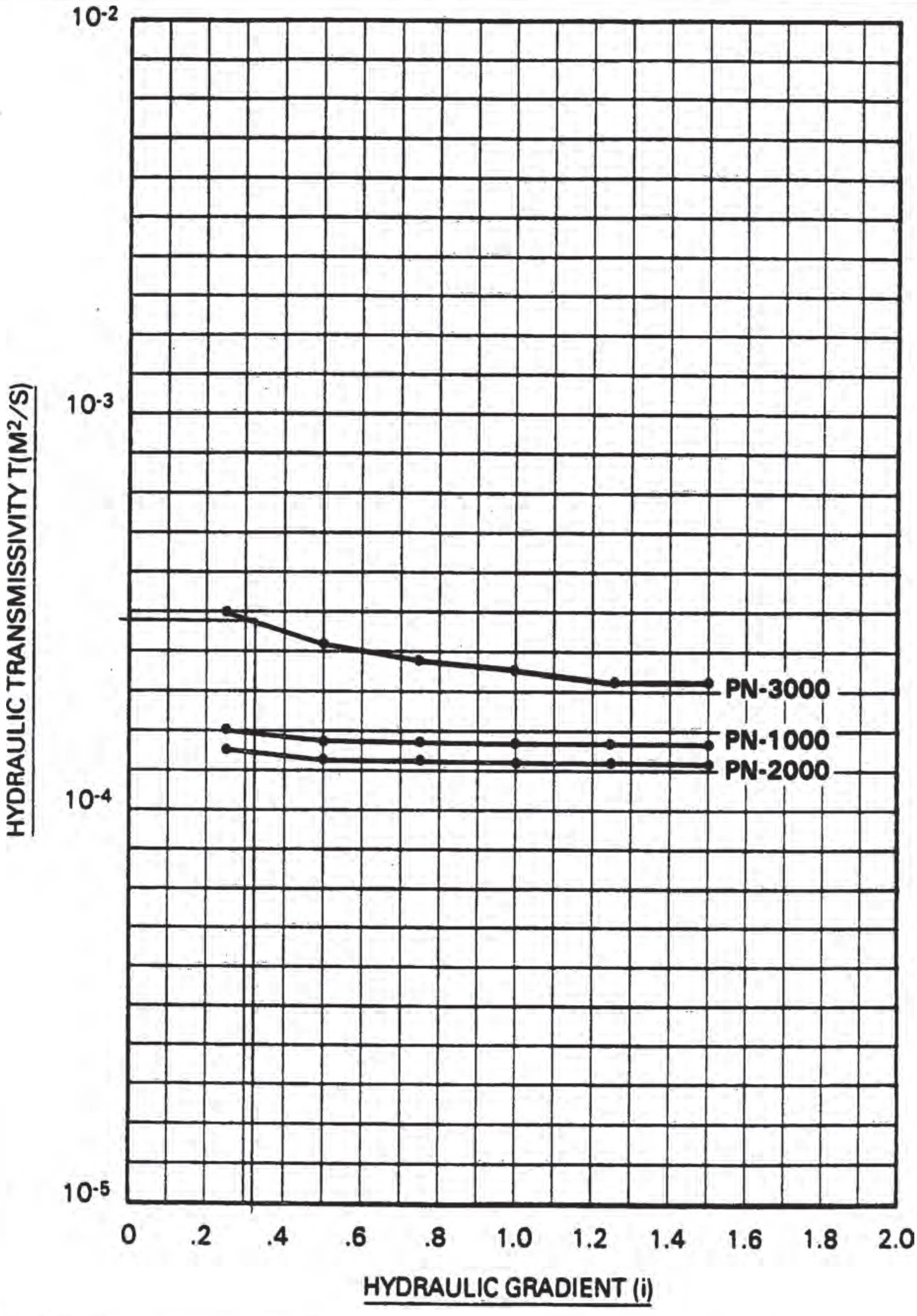
$$T_{NET} = 8.93\ \text{IN}^3/\text{SEC}/\text{FT WIDTH} \gg T_{SAND} = 0.192\ \text{IN}^3/\text{SEC}/\text{FT WIDTH}$$

## CONCLUSION

THE TRANSMISSIVITY OF THE GEONET EXCEEDS THE TRANSMISSIVITY OF THE 12 IN SAND LAYER. $T_{NET} = 8.93\ \text{IN}^3/\text{SEC}/\text{FT WIDTH} \gg 0.192\ \text{IN}^3/\text{SEC}/\text{FT WIDTH}$

P. 2 of 2

| POLY-NET ™ TRANSMISSIVITY | INSTALLATION METHOD<br>CLAY SUBGRADE<br>GEOTEXTILE (TREVIRA 2125)<br>POLY-NET AND 60 MIL LINER | HYDRAULIC PRESSURE<br>10000 P.S.F. |
|---|---|---|




NSC NATIONAL SEAL COMPANY

600 N. FIRST BANK DRIVE
PALATINE, ILLINOIS 60067
800/323-3820
312/991-6926

ITEM 8

STRESSES ON LEACHATE PIPES

| BY RCM DATE 2/6/96<br>CHK'D SMM DATE 2/13/96 | FRED C. HART ASSOCIATES, INC. | SHEET 1 OF 8 PAGE |
|---|---|---|

SUBJECT PROTECO - GEOTECHNICAL [illegible] JOB NO. B511
STRESS [illegible] MENT AND OVERBURDEN
SCHEDULE 80 PVC PIPE

PROBLEM STATEMENT

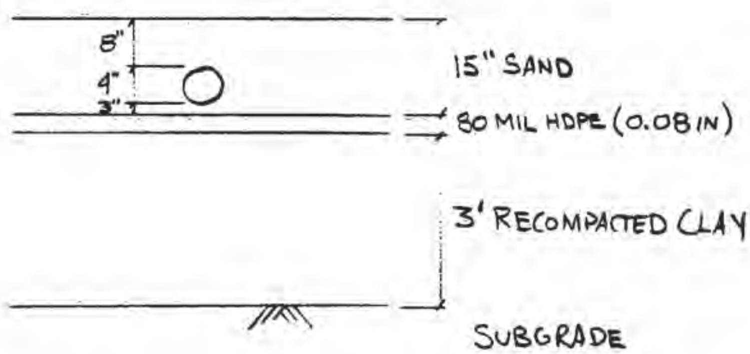
DETERMINE THE STRESSES CAUSED BY EQUIPMENT ON: A) THE HDPE LINER, AND B) THE PVC PIPE.

ASSUMPTIONS AND REFERENCES

- ASSUME A MAXIMUM EQUIPMENT LOAD OF A D8L DOZER (CONSERVATIVE)
- ASSUME THE MINIMUM SAND LAYER THICKNESS OF 15 INCHES.
- ASSUME A 2:1 STRESS DISTRIBUTION.
- USE ELASTIC THEORY FOR SETTLEMENT CALCULATION.
- REF. - CATERPILLAR PERFORMANCE HANDBOOK, 16TH EDITION
- REF. - SOIL MECHANICS, PERLOFF AND BARON, p. 199
- REF. - NIPAKpipe Engineering Manual
- REF. - ESLON PIPING PRODUCTS

SOLUTION

LINER SYSTEM



SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. 8511

STRESS DUE TO EQUIPMENT AND OVERBURDEN

SCHEDULE 80 PVC PIPE

## D8L DOZER

WIDTH OF STANDARD TRACK SHOE = 22 IN. = 1.83 FT.

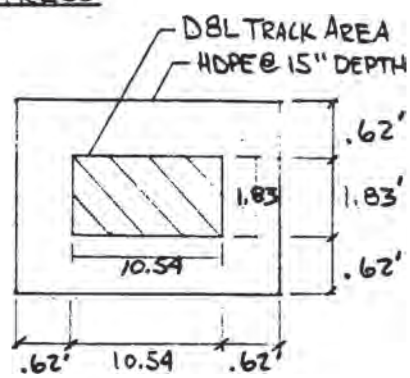
LENGTH OF TRACK ON GROUND = 10'6.5 IN = 126.5 IN. = 10.54 FT.

OPERATING WEIGHT = 82,489 LB.

GROUND CONTACT AREA = 5566 $IN^2$ (2 TRACKS)

$$\text{GROUND PRESSURE} = \frac{82489}{5566} = 14.82 \text{ PSI} \quad \underline{\text{USE } 20 \text{ PSI}}$$

## LINER STRESS




$$A_{SURFACE} = 22(126.5)/144$$

$$A_{LINER} = (22+15)(126.5+15)/144$$

$$\frac{A_{SURFACE}}{A_{LINER}} = 0.532$$

$$\sigma_{LINER} = 20 \text{ PSI}(0.532)$$

$$\underline{\sigma_{LINER} = 10.64 \text{ PSI}}$$

## SETTLEMENT

$L = 10.54 + 2(.62) = 11.8'$

$B = 1.83 + 2(.62) = 3.1'$

$L/B = 3.81$

$C_s = 1.91$ BY LINEAR INTERPOLATION (PERLOFF & BARON TEXT, TABLE 5.1 FOR CENTER OF LOADED RECT. AREA AT SURFACE OF ELASTIC HALFSPACE)

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|---|---|---|
| CHK'D BMM DATE 2/13/86 | | |

SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. 8511
STRESS DUE TO EQUIPMENT LOAD AND OVERBURDEN
SCHEDULE 80 PVC PIPE

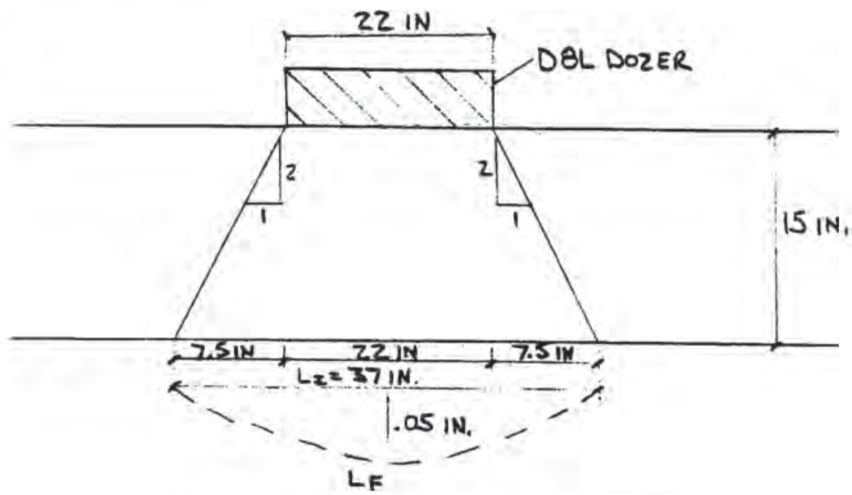
$$\rho_D = C_s\, q\, B\left(\frac{1-\mu^2}{E}\right)$$

$$\rho_D = 1.91(10.64\times144)\,3.1\left(\frac{1-0.5^2}{1500\times10^3}\right)$$

$$\rho_D = .0045 \text{ FT}$$

$$\rho_D = .054 \text{ IN}$$

A)




$$L_F = \sqrt{4x^2+y^2} + \frac{y^2}{2x}\ln\left[\frac{2x+\sqrt{4x^2+y^2}}{y}\right]$$

$$x = .05,\ y = 37/2 = 18.5$$

$$L_F = 18.500 + 3422.5\ (0.0054)$$

$$L_F = 37 \text{ IN.}$$

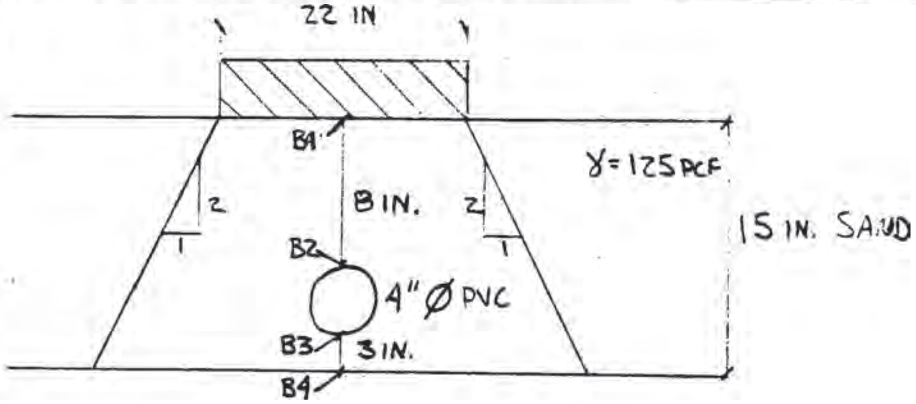
$$\Delta L = L_I - L_F \approx 0$$

$$\text{STRAIN} = \Delta L / L \approx 0$$

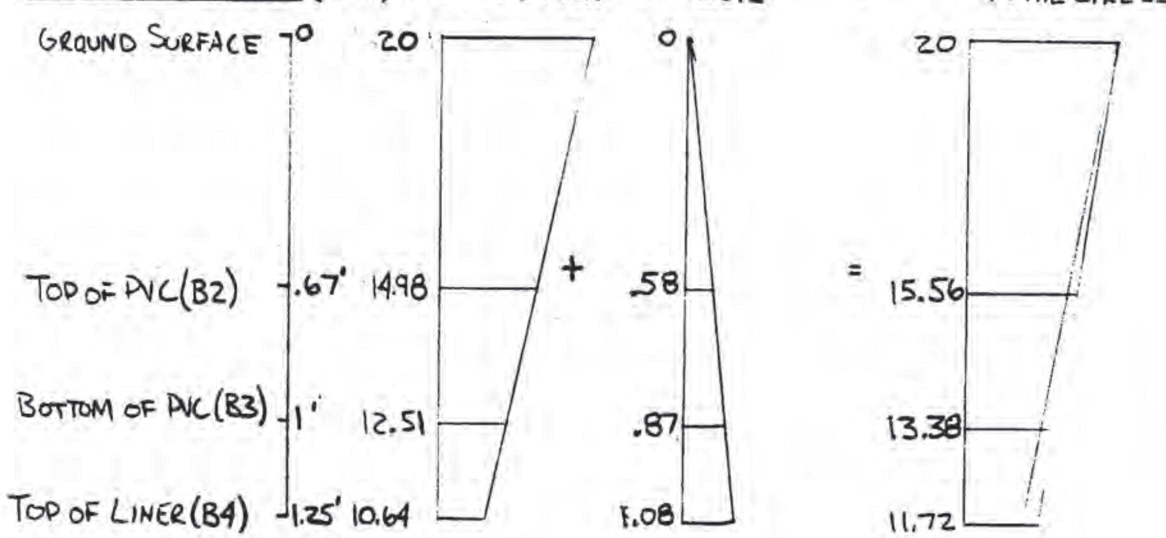
$\therefore$ MINIMAL STRESS INDUCED.

SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. B511
STRESS DUE TO EQUIPMENT AND OVERBURDEN
SCHEDULE 80 PVC

B)




VERTICAL STRESS (PSI) → DBL DOZER + SOIL = TOTAL STRESS




## PIPE DEFLECTION

$$\text{PIPE DEFLECTION}(\%) = \frac{D \times K \times P \times 100}{\left[2E/3\,(DR-1)^3\right] + 0.061\,E'} \quad \text{(SPANGLER)}$$

WHERE $\gamma$ = SOIL DENSITY
E = MODULUS OF ELASTICITY OF PIPE
P = PRISM LOAD = $\gamma H$
K = BEDDING CONSTANT
E' = MODULUS OF SOIL REACTION
D = DEFLECTION LAG FACTOR = 1.50
DR = DIMENSION RATIO = OUTSIDE DIA./TH

| | | |
|---|---|---|
| BY RCM DATE 2/10/86<br>CHK'D BMW DATE 2/13/86 | **FRED C. HART ASSOCIATES, INC.** | SHEET 5 OF 8 PAGE |

SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. 8511
STRESS DUE TO EQUIPMENT, OVERBURDEN
SCHEDULE 80 PVC PIPE

$\gamma$ = 125 PCF

E = $4.2 \times 10^5$ PSI (Schedule 80 PVC from R&Sloane Manufacturing)

P = 15.56 PSI (CONSERVATIVE

K = 0.10 0.11 - 0.083 typical, 0.11 is conservative (p.218 WPCF #9)

E' = 3000 PSI coarse-grained soil, density > 70% (Bulson text)

L = 1.50 for polyethylene (NIPAK)

p. 220 WPCF Manual of Practice #9 suggests...

use D = 1.50 and K = 0.10

DR = 4.500/.337 = 13.35 (R&Sloane)

$$\text{PIPE DEFLECTION} = \frac{1.50(0.10)(15.56)100}{\frac{2(4.2\times10^5)}{3(13.35-1)^3} + .061(3000)}$$

$$= 0.704\% \ll 7\% \quad \underline{OK}$$

PIPE DEFLECTION IS TOLERABLE FROM A PIPE CRUSHING STANDPOINT.

| | | |
|---|---|---|
| BY RCM DATE 2/6/86<br>CHK'D BMW DATE 2/13/86 | **FRED C. HART ASSOCIATES, INC.** | SHEET 6 OF 8 PAGE |

SUBJECT PROTECO - GEOTECHNICAL ANALYSIS JOB NO. 8511
STRESS DUE TO EQUIPMENT AND OVERBURDEN
SCHEDULE 80 PVC PIPE

B) DETERMINE IF 100 FT. OF OVERBURDEN ON TOP OF PIPE IS ACCEPTABLE.

$$P = \gamma H = 125\ PCF(100\ FT)\left(\frac{FT}{12IN}\right)^2 = 86.8\ PSI$$

$$\text{PIPE DEFLECTION} = \frac{1.50(0.10)(86.8)100}{\frac{2(4.2\times10^5)}{3(13.35-1)^3} + .061(3000)}$$

$$= 3.92\% < 7\% \quad \text{OK}$$

PIPE DEFLECTION IS TOLERABLE FROM A PIPE CRUSHING STANDPOINT.

# Selection Data — Hi-Strength Schedule 80™ PVC Fittings

## Compressed Air or Gases

R&G Sloane strongly recommends against testing assembled PVC piping systems with compressed air or other compressed gases and against using PVC systems for distribution of compressed air or gases.

## Physical & Thermal Properties of Polyvinyl Chloride(PVC) Pipe (See note #2 below)

| | |
|---|---|
| Specific Gravity | 1.4 |
| Izod Impact Strength (ft lbs/inch of notch) | 0.8 |
| Tensile Modulus, psi | $4.2 \times 10^5$ |
| Ultimalte Tensile Strength, psi | 7200 |
| Working Stress @ 73°F, psi | 2000 |
| Working Stress at Upper Temperature limit, (140°F) psi | 440 |
| Hazen & Williams "C" factor | 150 |
| Coefficient of Linear Expansion $10^{-5}$ in/in/°F | 3.0 |
| Thermal Conductivity BTU/hr/ft²/in/°F | 1.10 |
| Upper Temperature Limit | 140°F |

Flammability — Burns only when in contact with ignition source.

## Chemical Resistance of PVC

| | |
|---|---|
| Weak acids | Resistant |
| Strong acids | Resistant in most situations |
| Weak bases | Resistant |
| Strong bases | Resistant |
| Solvents | Resist alcohols, aliphiatic hydrocarbons, and oils. Soluble or swell in ketones and esters. Swell in aromatics. |
| Halogens | Attacked by elemental halogens. Resists water solutions. |

## Sample Specification for PVC Schedule 80 Pressure Fittings and Pipe

PVC Schedule 80 pressure fittings shall be manufactured by R&G Sloane and to the requirements of ASTM D-2464 (threaded type) and ASTM D-2467 (Solvent cement socket type) except that the socket wall thickness of socket type fittings and the socket wall thickness over the threads of threaded type fittings shall be at least 125% of the wall of the equivalent size of Schedule 80 pipe, and except that the body wall thickness shall be 150% of the wall of the equivalent Scheudle 80 pipe. All internal threads shall be machine tapped to the requirements of ANSI B2.1. The quick burst strength of the fittings shall be equal to or greater than the burst strength of the equivalent Schedule 80 PVC pipe. Shall be made of PVC 12454-B or better.

### PRESSURE RATING VS. SERVICE TEMPERATURE PVC SCHEDULE 80 PIPE

| Nom. Size | Outside Dia. | Wall | DR = D/t | 73°F f = 1 S = 2000 P | 80°F f = 0.88 S = 1760 P | 90°F f = 0.75 S = 1500 P | 100°F f = 0.62 S = 1240 P | 110°F f = 0.50 S = 1000 P | 120°F f = 0.40 S = 800 P | 130°F f = 0.30 S = 600 P | 140°F f = 0.22 S = 440 P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/8 | .405 | .095 | 4.623 | 1230 | 1082 | 923 | 763 | 615 | 492 | 369 | 271 |
| 1/4 | .540 | .119 | 4.535 | 1130 | 994 | 848 | 701 | 565 | 452 | 339 | 249 |
| 3/8 | .675 | .126 | 5.357 | 920 | 810 | 690 | 570 | 460 | 368 | 276 | 202 |
| 1/2 | .840 | .147 | 5.714 | 850 | 748 | 638 | 527 | 425 | 340 | 255 | 167 |
| 3/4 | 1.050 | .154 | 6.818 | 690 | 607 | 518 | 428 | 345 | 276 | 207 | 152 |
| 1 | 1.315 | .179 | 7.346 | 630 | 554 | 473 | 391 | 315 | 252 | 189 | 139 |
| 1 1/4 | 1.660 | .191 | 8.691 | 520 | 458 | 390 | 322 | 260 | 208 | 156 | 114 |
| 1 1/2 | 1.900 | .200 | 9.500 | 470 | 414 | 353 | 291 | 235 | 188 | 141 | 103 |
| 2 | 2.375 | .218 | 10.894 | 400 | 352 | 300 | 248 | 200 | 160 | 120 | 88 |
| 2 1/2 | 2.875 | .276 | 10.416 | 420 | 370 | 315 | 260 | 210 | 168 | 126 | 92 |
| 3 | 3.500 | .300 | 11.666 | 370 | 326 | 278 | 229 | 185 | 148 | 111 | 81 |
| 3 1/2 | 4.000 | .318 | 12.578 | 350 | 308 | 263 | 217 | 175 | 140 | 105 | 77 |
| 4 | 4.500 | .337 | 13.353 | 320 | 282 | 240 | 198 | 160 | 128 | 96 | 70 |
| 5 | 5.563 | .375 | 14.834 | 290 | 255 | 218 | 180 | 145 | 116 | 87 | 64 |
| 6 | 6.625 | .432 | 15.336 | 280 | 246 | 210 | 174 | 140 | 112 | 84 | 62 |

$$P = \frac{2St}{D-t} = \frac{2S}{DR-1} = P_{73^\circ F} f$$

P = Pressure Rating of Pipe at Service Temperature (PSI)

S = Hydrostatic Design Stress (PSI)

D = Outside Diameter Pipe (inches)

t = Pipe Wall Thickness (inches)

f = Derating factor for service temperature

DR = Dimension Ratio = D/t

$P_{73^\circ F}$ = Press. Rating at 73°F

NOTE: 1) Figures for Pressure Rating at 73°F are rounded off from actual calculated values, and are the same as found in Table X2 of ASTM D-1785. Pressure Ratings for other temperatures are calculated from 73° F values.

2) Pressure Rating values are for PVCI pipe, and for most sizes are calculated from the experimentally determined Long Term Strength of PVCI extrusion compounds. Because molding compounds may differ in long term strength and elevated temperature properties from pipe compounds, piping systems consisting of extruded pipe and molded fittings may have lower pressure ratings than those shown here, particularly at the higher temperatures. Caution should be exercised in design of systems operating above 100°F.

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Form PVC-1-84 Litho in U.S.A. 11/84

Noting that $e_s = p/E_s$, we get

$$\Delta X = 5pR/E_s, \tag{4.28}$$

which gives a value for $\Delta X$ about 25% greater than the approximate equation (4.23).

Returning to equation (4.14), an often-used rearrangement is

$$\Delta X = \frac{\gamma_B \gamma_T W_c}{EI/R^3 + 0.061E'}, \tag{4.29}$$

where $E' = kR$. This was suggested by Watkins and Spangler [4.5], who pointed out that $kR$ was dimensionally correct, and similar to the compressive modulus of elasticity of soil – a pipe–soil interaction modulus in fact. Further, $EI/R^3$ can be regarded as a 'ring stiffness' factor, because it is the product of the elastic modulus of the pipe wall material and the moment of inertia of unit length of the cross section ( $= t^3/12$). Thus,

$$\Delta X = \frac{\text{loading parameter}}{\text{ring stiffness factor} + \text{soil stiffness factor}}. \tag{4.30}$$

Tests by the US Bureau of Reclamation, reported by Howard [4.6], give values for $E'$ in pounds per square inch as in Table 4.2.

These figures were representative of calculations based on measurements in 113 field installations in which initial deflections were measured after construction; pipe deflection was measured between the time of placing the soil to the top of the pipe and completion of backfilling; the horizontal deflection $\Delta X$ was measured in most instances. If $\Delta X$ was not measured, but the vertical deflection $\Delta Y$ was known, then it was assumed that $\Delta X = 0.913\,\Delta Y$, which is the ratio given by equations (4.6) and (4.7). Howard

**Table 4.2** Values for $E'$ (psi)

| | Relative density (Proctor) | | | |
|---|---|---|---|---|
| | Dumped | < 40% | 40–70% | > 70% |
| Fine-grained soils with less than 25% coarse-grained particles | 50 | 200 | 400 | 1000 |
| Fine-grained soils with more than 25% coarse-grained particles | 100 | 400 | 1000 | 2000 |
| Coarse-grained soils | 200 | 1000 | 2000 | 3000 |
| Crushed rock | 1000 | 3000 | 3000 | 3000 |

From Bulson, P.S., Buried Structures, Chapman and Hall, New York, 1985.

ITEM 9

LEACHATE HEAD/DRAIN SYSTEM

EVALUATION (to be provided)

APPENDIX D-6.3

LANDFILL AND

SURFACE WATER MANAGEMENT FACILITIES

QUALITY ASSURANCE MANUAL

FOR THE INSTALLATION OF HOPE GEOMEMBRANES

This material was previously submitted January 31, 1986; PROTECO PROJECT MASTER DOCUMENTS LIST - Plans and Specifications.

(0641B-9)

APPENDIX D-6.4

LANDFILL AND

SURFACE WATER MANAGEMENT FACILITIES

HAZARDOUS WASTE LANDFILL AND

SURFACE WATER MANAGEMENT FACILITIES

Technical Specification

This material was previously submitted January 31, 1986; PROTECO PROJECT MASTER DOCUMENTS LIST - Plans and Specifications.

# APPENDIX D-6.5

## LANDFILL AND

## SURFACE WATER MANAGEMENT FACILITIES

## SURFACE WATER MANAGEMENT

## CALCULATIONS

This material was previously submitted January 31, 1986; PROTECO PROJECT MASTER DOCUMENTS LIST - Plans and Specifications.

## D-7 Land Treatment

There are no land treatment facilities proposed.

(0650B-6)

## D-8 Waste Piles

There will be no waste piles at the Proteco Facility

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SECTION D-9 STABILIZATION/FIXATION FACILITY



(0629B)

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(CONTINUED)

# D-9 STABILIZATION/FIXATION FACILITY

## D-9a General

The PROTECO facility will include a process to stabilize/fix incoming wastes whose physical form, i.e., containing free liquids, (per the "paint filter test" criteria method 9095 of SW-846" Test Methods for Evaluating Solid Waste" delineated on Table C-8) would exclude direct burial in the secure landfills under 40 CFR 264.314, or for wastes which must be treated prior to land disposal.

This process will be conducted in the Stabilization/Fixation Facility located northwest of the entrance gate within the same area allotted for the Tank Storage and Treatment and Container Storage facilities, as shown on drawing B511-C-SL3.

The Stabilization/Fixation Facility technical specification and drawing set are referred to as necessary, and can be found in Appendices D-9.1 and Appendix A, respectively. Supporting tank calculations are provided in Appendix D-9-4.

## D-9b Facility Description

The facility will occupy approximately one-third of an acre. This area allows for a future "twin" to the proposed unit to be built adjacent to the initial facility as shown on drawing 511-D-F20. This Part B Application is for both units.

The proposed facility design incorporates personnel safety features, prevention of fire, sudden and non-sudden releases of hazardous which could threaten human health or the environment, and administrative and process control procedures to assure process operation resulting in a stabilized/fixed product suitable for land disposal. The facility description follows.

The technical specifications require construction in accordance with the local building codes. The stabilization/fixation process will be conducted in a building. Overall building dimensions are approximately 50' wide by 50' long by 51' high. The building foundation consists of a 1' reinforced concrete slab (as shown on drawings B511-D-F20 to F22).

The building roof decking slopes down directing rainfall to a gutter and down spout. The roof extends around and over the lower section of the stabilizing/fixing material silos at the southern end of the building with flashing provided as a seal. This section of the roof also has a gutter and downspout to direct rainfall away from the facility. The aluminum coated steel siding extends down to within 5' of grade. Four ventilators are provided on the roof (as shown on the architectural drawings, numbers B511-D-A20 and A21).

The steel building structure is designed per AISC codes with cross-bracing for the wind loading per local codes. The internal structure consists of three elevations; grade, 20' and 34'. The upper platforms are constructed of steel grating. Floor drains are directed to a double lined sump with leak detection.

The roof drainage design, curbing around the facility and internal drainage sump design prevent run-off of spills to the environment and run-on of rainfall into the facility. Spill containment and cleanup procedures are discussed in Section D-9f below.

Personnel and equipment safety considerations have been incorporated into the design. Personnel entrances/exists are located at either end of the silo wing, at the rear of the eastern side of the building, at the 20' platform via stairs dropping down off the silo area, and through the truck tipping and discharge bays. A stairwell extends up to the 34' platform from the truck discharge bay area (all stairs and walkways conform to OSHA codes). Four (4) eyewash/shower stations are provided at the facility.

A sprinkler system over the process unit is central to the facilities fire protection fixing additives. The facility's safety and fire protection is discussed in Section D-9g below.

## D-9c Process Description

The proposed Stabilization/Fixation Facility is capable of mixing fly ash or cement kiln dust, with dry limestone to sludge, solids, or liquid waste streams. Figure 1 presents a simplified block flow diagram of the stabilization/fixation process indicating design and maximum flows of all streams. This process, referred to as a modified "pozzolanic" process, utilizes the hydration of silicate compounds (typified by the common cement reaction) to improve the waste characteristics and produce a matrix constituting a stabilized/fixed product suitable for landfilling in accordance with the regulations cited above.

D-9c(1) General. The following process description is depicted on the P & ID drawings nos. B511-D-SK24, 25, and 26.

The ratio of waste to stabilizing/fixing agents additives will vary for each waste per the pre-acceptance waste stabilization/fixation testing, described under administrative/process controls below. The anticipated range and design throughputs are as follows:

| | Hourly Range* | Hourly Design* |
|---|---|---|
| Sludges/Solids | 0 - 5 tons | 2.5 tons |
| Liquids | 0 - 3 (700 gallons) tons | 2.0 tons (500 gallons) |
| Stabilizing/Fixing Additives | 0 - 9 tons | 7.5 tons |
| Total to Landfill | 0 - 16.5 tons | 12.0 tons |

*Per Facility - Two facilities are proposed in this Part B Application.

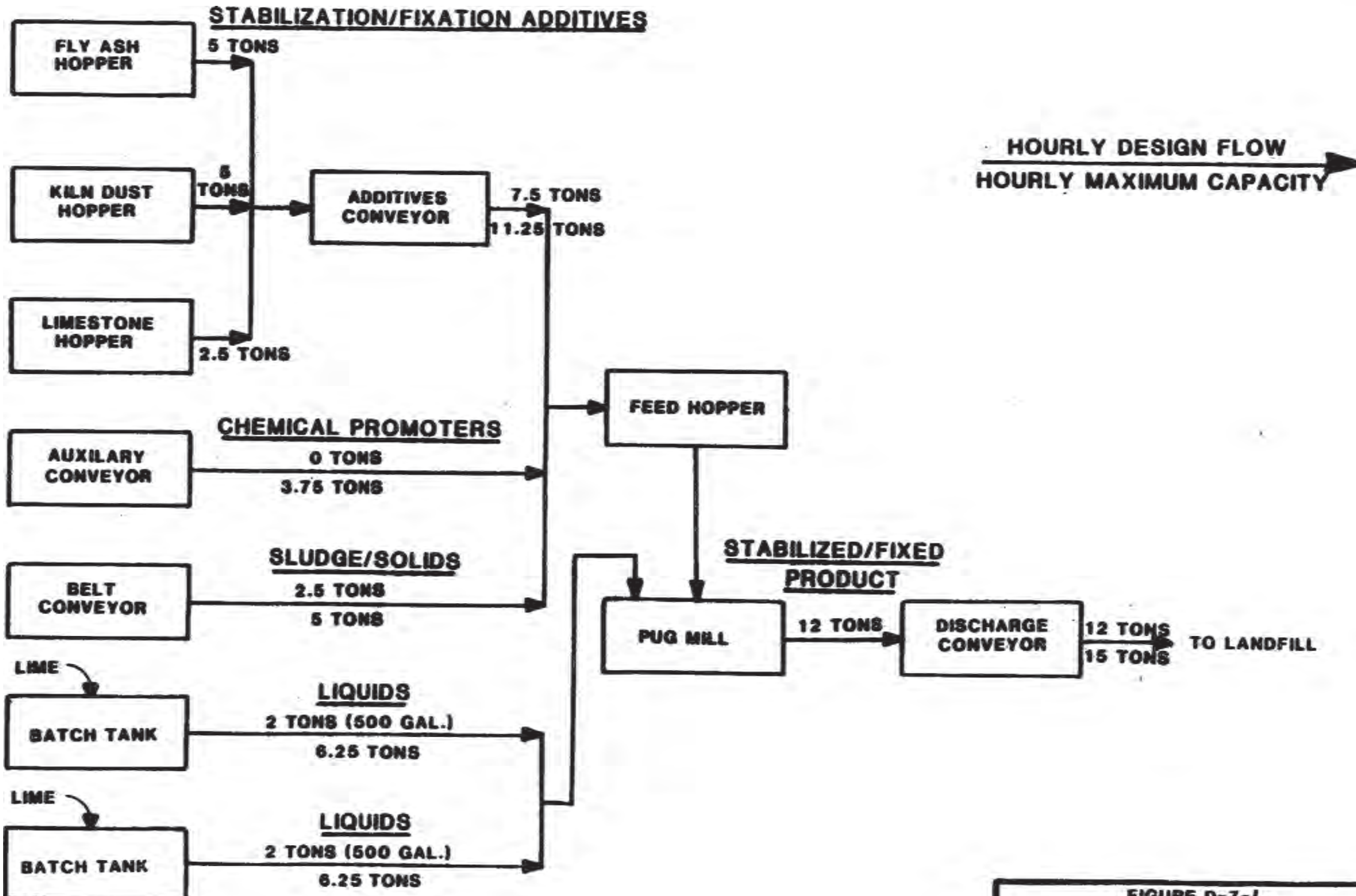


FIGURE D-7-1

STABILIZATION FACILITY SIMPLIFIED FLOW DIAGRAM PROTECO

FRED C. HART ASSOCIATES, INC.

The system can be operated to stabilize/fix sludges, solids and/or liquids.

The hourly design throughput, 12.0 tons corresponds to approximately 24 cubic feet per hour. The system is capable of achieving a waste to stabilizing/fixing additive ratio of 1:3. While the operating equipment provides for variable feed flowrates, normal operating conditions are expected to be within the mixture ratio range of 1:1 to 1:3.

All the feeds converge at the pug mill which is the center of the system. The pug mill is a high speed, low residence time, mixer/granulator. Waste liquids are fed from tanks to distributers located in top of the pug mill. Waste sludges/solids and the additives are conveyed into a feed hopper situated over the screw feeder on the pug mill. The pug mill discharges through another screw conveyer which serves to drop the stabilized/fixed product into a dump truck for transport to the landfill.

The system operates as a semi-continuous process; sludge/solids can be continuously unloaded and fed to the pug mill while liquids can be batch fed from the Tank Farm Storage/Treatment Facility through the batch tanks described below. Liquid feeds to the batch tanks can also be delivered by tanker truck or pumped from the liquids drainage sump in the Stabilization/Fixation Facility.

The system provides for the conditioning and feeding of liquid wastes for stabilization/fixation through two (2) 2,000 gallon batch tanks. Batch tank T-9 is to be used for solvents (both non-halogenated and halogenated), oil sludge, or oil wastes from the Tank Farm. Batch tank T-13 is to be used for aqueous wastes, or alkali and acid wastes neutralized in the neutralization tank. The waste characteristics of the batch wastes in these tanks would either be mixtures or the same wastes as described for each tank in the Tank Farm (see Section D-4d). The batch tanks both have mechanical mixers and provisions for lime slurry addition for pH conditioning. The feed flow rate from these tanks is manually adjusted by the operator, at a throttling value upstream of a flow meter, on the discharge end of the transfer pump. (The pre-acceptance waste stabilization/fixation testing described under Administrative/Process controls below, serves to establish the formulation ratios for the process.) The maximum flowrate is 1,500 pounds per hour (1,500 gph) or three times the design throughput of 500 gallons per hour, feeding under normal conditions from one batch tank.

Sludges and solid wastes to be stabilized/fixed by the treatment additives are delivered by dump truck to the tipping area. The sludge/solids are dropped on to the tipping floor and loaded, into a conveyor feed-hopper, by a front end loader to be stationed in the tipping area. The belt conveyor, referred to as the inclined solids conveyor (C-1), has a variable speed in order to allow for adjustments of the delivery rate to the pug mill feed hopper for density and consistency of each sludge/solids feed. At full capacity, this conveyor can deliver 10,000 pounds (5 tons) per hour to the process or two times the design throughput of 5,000 pounds (2.5 tons) per hour. The sludge/solids drop into the pug mill feed hopper where, at the treatment additives inlet, a grinder extends off the additives conveyor drive shaft to inhibit clumping or bridging of the feeds in the hopper.

The treatment additives; dry limestone, fly-ash, and cement kiln dust, are fed from their storage hoppers, T-10, T-11, and T-12 respectively, by screw feeders. These screw feeders are operated by variable speed motors to allow for control of the flowrates and proportional mixing as required by the specified waste stabilization/fixation formulation. The fly-ash, and kiln dust screw feeders (C1-T11 and C1-T12) have a 10,000 pounds per hour capacity, while the limestone screw feeder capacity (C1-T10) is 5,000 pounds per hour. These feeds drop onto the pug mill feed transfer conveyor (C-2) rated at 22,500 pounds (11.25 tons) per hour, or one and a half capacity over the design throughput, and also driven by a variable speed motor. This conveyor feeds in turn, into the pug mill feed hopper where it is assisted by the sludge grinder at its discharge end.

The pug mill serves as the mixer/treatment vessel for the stabilizing/fixing process. The proposed pug mill is a rotary solids/ liquids mixer employing pins extending off the rotor shaft to mix and transport the material. The high speed, 600 rpm, rotation of the shaft creates vortices of high mixing behind the pins. The helical positioning of the pins serves to transport the material. The dry feed, waste sludge/solids and the stabilizing/fixing additives, are fed to the pug mill through the feed hopper located overhead of the pug mill's screw feeder. Waste liquids are piped directly to the pug mill housing and atomized by the pug mill action, rather than by spray nozzles prone to plugging. Feed rates are controlled upstream of the pug mill as described above.

The pug mill design capacity defines the overall system process rate at 10 dry tons per hour, or 12 tons per hour total. The unit has a high turn-down ratio and could be operated at rates as low as five tons per hour.

Discharge from the pug mill drops into the discharge conveyor which transfers the stabilized/fixed product to the location overhead of the discharge floor for loading the trucks destined for the landfill. The discharge conveyor is a screw conveyor of fixed speed 30,000 pounds per hour or one quarter capacity over the design throughput capacity of 24,000 pounds per hour.

An auxiliary conveyor is provided overhead of the pug mill feed hopper to allow for the addition of stabilizing/fixing promoting chemicals, if needed. This screw conveyor is to have a capacity of 7,500 pounds per hour.

D-9c(2) <u>Stabilization/Fixation Chemistry and Formulations</u>. The proposed facility utilizes a modified "pozzolanic process", similar to the setting of cement, to improve the waste characteristics and chemically treat and stabilize/fix the hazardous waste into a matrix suitable for land disposal.

This chemical treatment chemically transforms the liquid portion of the waste into a solid and the hazardous constituents into less soluble and/or less toxic forms. The liquids and hazardous constituents are directly incorporated into or encapsulated between the resulting crystal structure, thereby limiting their mobility, solubility or toxicity, and rendering them less amenable to environmental mobility.

The "pozzolanic process" involves hydration, neutralization, precipitation, and crystalization reactions. The composition of the waste, the fly ash or cement kiln dust, pH of the waste, and mixture ratios (formulations) are factors effecting the extent and type of each reaction and therefore the properties of the stabilized/fixed product.

D-9c(2)a Stabilization/Fixation Formulations. The following discussion outlines the chemistry of the "pozzolanic process", as it relates to the wastes and additives to be stabilized/fixed at the site, and the range of mixture formulations provided for in the process design.

The hydrolysis-crystalization reactions are the primary processes responsible for water dissipation resulting in the formation of a solid matrix suitable for landfilling. The hydrolysis reactions of calcium oxide compounds with silicates, aluminates and aluminoferrite are typical cement setting processes. The calcinated silicates or aluminates are then in a suitable form for direct fixation reactions with heavy metals, hydration or for fixation of non-metal compounds encapsulated within the crystals matrix.

Neutralization reactions are necessary to promote the formation of both the more readily hydrated calcium silicates and the metal precipitates to be fixed or bound with the silicate crystals, where sulfates, metal oxides, and alkaline silicates (e.g., alumino, cadmium, and potassium silicates) are present. These precipitation reactions and the subsequent crystallizations are favored in the pH range 9 to 11.

These competing and inhibiting compounds may be present in the fly ash and/or cement kiln dust as these materials are not specification products. Fly ash, being the oxidized metal compounds, silicates, alumina, inerts, and any miscellaneous compounds carried off as remaining ash during the combustion of fossil fuel, is expected to display a wide variety of both the calcium silicates and other compounds mentioned above.

The composition of the fly ash may also vary from batch to batch. The composition of fly ash regarding its pozzolanic properties is characterized by the "lime saturation factor;" the ratio of calcium oxide to silicates, aluminum and iron oxides. The quantity of dry limestone to be added to the fly ash would be determined during the pre-stabilization/fixation testing. The "lime saturation factor" relates to the limestone addition as the limestone provides calcium oxide for combination with the silicates and aluminates and to precipitate the heavy metals for incorporation into the pozzolanic matrices.

Cement kiln dust, while generally having better pozzolanic properties than fly ash, is a by-product of cement manufacturing and tends to contain alkaline silicates that inhibit the "pozzolanic" reactions. Therefore, dry limestone is added per the pre-stabilization/fixation testing, to provide the calcium oxide.

In general, since the metal precipitation reactions for the metals contained in the fly ash, kiln dust or wastes are favored by pH conditions in the range 9 to 11, a preliminary guideline for an acceptable pH range of wastes for stabilization/fixation processing would be 6.5 to 11. This guideline will be refined during the pre-stabilization/fixation testing for each waste.

Where the sludge/solids wastes to be stabilized/fixed are acidic, the dry limestone in the stabilizing/fixing additive mixture would result in a neutralized mixture of a pH promoting the precipitation reactions described above. The batch tanks, having provisions for pH adjustment by lime slurry addition, would serve to condition acidic liquid wastes up to the desired pH range prior to stabilization/fixation processing.

The presence of metal sulphate (e.g., iron, cadmium or magnesium sulfate) or chloride compounds in the wastes or fly ash represent specific known inhibitors of the "pozzolanic" reactions. These compounds are very soluble, therefore, in order to precipitate them for incorporation into the stabilized/fixed matrix, further lime addition or the use of a chemical promoting agent may be necessary to react them to insoluble compounds.

The chemical additions conveyor allows for the addition of "pozzolanic" promoting chemicals to the mixture in the event of a waste exhibiting very poor stabilization/fixation; in particular, the granulated sodium silicates. Granulated sodium silicate is readily available and relative to most commercial chemicals, inexpensive. It reacts with all polyvalent metal ions, acids, and some organics and does note require the alkaline pH conditions. As an additive, it broadens the chemical and pH conditions tolerance of the "pozzolanic" reactions. Due to its higher cost over cement kiln dust, fly-ash, or limestone, sodium silicate is not intended for addition to the process under normal conditions. As an additive in waste stabilization/fixation processing, sodium silicate is currently being used by the speciality contractors providing these services and can be used at PROTECO if needed for specific formulations.

Organics also tend to have an adverse effect on the "pozzolanic" reactions. Depending on the organic content and character, the process could satisfactorily encapsulate them, but may require the addition of a chemical-promoting agent. Where the sodium silicate additives are not sufficient to accommodate the wastes containing organics, proprietary polymer additives will be obtained from specialty contractors (e.g., Dow markets such an additive).

D-9c(2)b Stabilization/Fixation Formulations. The term formulation is used herein to describe the waste to stabilization/fixation additive to chemical additive, if necessary, mixture ratios to achieve a product suitable for landfilling per the "paint filter test" mentioned above.

The site laboratory will perform stabilization/fixation tests on wastes designated for stabilization/fixation processing as part of the waste pre-acceptance testing. These tests will be performed on samples delivered by the generator with the waste preacceptance sheets. In addition, prior to actual processing the laboratory will perform verification tests on the specified waste stabilization/fixation formulations as necessary where the composition has been altered due to mixing in storage facilities, pH conditioning, etc.

The possible formulations are bounded by the system process flowrates. However, the system has been designed to allow a range of formulations under normal operating conditions from 1:3 to 1:1/2 waste to stabilizing/fixing additives. This range is expected to provide adequate processing conditions for most wastes suited for stabilization/fixation. In addition, the chemical additions conveyor allows for addition of hydrolysis-crystalization promoting chemicals, if necessary. Excessive addition of stabilizing/fixing additives will result in a product that will pass the "paint filter test" but is uneconomical. Insufficient addition of stabilizing/fixing additives could result in an end product not suitable for landfill disposal and requiring reprocessing or other special handling resulting in additional labor costs and lost time. The laboratory, in specifying formulations reflective of actual process capabilities, will add a safety factor to the laboratory determinations to accommodate the scale up to the full size process where variables such as homogeneous mixing may not be achievable to the degree possible in the laboratory.

In the case where the chemical additive is needed, its mixture proportions would be included in the formulation. Typical applications by the hazardous waste stabilization/fixation processing speciality contractors have utilized this additive in proportions of approximately one to two tenth parts per part waste.

D-9c(3) Stabilization/Fixation Procedures and Control. The following section describes the procedures for stabilizing/fixing liquid and sludge/solid wastes and the related administrative and process controls.

D-9c(3)a Waste Stabilization/Fixation Processing Controls. Both administrative and process controls have been provided for the stabilization/fixation facility to assure processing to achieve a product suitable for landfilling and to prevent damage to equipment or inadvertent processing circumstances requiring implementation of the Contingency Plan and Emergency Procedures (Section G).

Administrative controls include the site wide use of the waste movement form to assure operator knowledge of the waste composition and inventory, pre-stabilization/fixation testing as required to either confirm or develop pre-acceptance test or redevelop stabilization/fixation formulations, and product discharge testing per the "paint filter test".

The site wide waste movement form would be applicable to any deliveries of sludge/solids to the Stabilization/Fixation Facility or any transfers of waste liquids to the Stabilization/Fixation Facility's batch tanks, including delivery from the Tank Farm tanks, tanker truck or liquid sump in the Stabilization/Fixation Facility. These forms are maintained in the laboratory, thereby resulting in cognizance of both the laboratory and plant operations personnel of any waste movements and providing a double administrative check.

The pre-stabilization/fixation testing serves as an administrative control to verify the generator waste pre-acceptance stabilization/fixation testing results. The originally developed formulations would be verified where, due to storage, mixing, conditioning, or intended mixing with another waste matrix (sludge/solids or liquid), the laboratory personnel determines the waste stabilization/formulation may need to be revised. Liquid waste samples would be taken from the sample ports provided on the recycle lines of the storage tanks in the Tank farm prior to transfer to the batch tanks in the Stabilization/Fixation Facility (adequate mixing time corresponding to a minimum of one turnover of the tank contents shall be employed prior to sampling to ensure collection of a representative sample). A sludge/solid waste sample would be taken from the delivery truck as per the facility's Waste Analysis Plan.

Prior to transfer to the landfill, a representative sample of the stabilized/fixed waste batch being processed would be collected and subjected to the "paint filter test" to assure proper stabilization/fixation processing has been achieved.

Through the collection and maintenance of the pre-acceptance stabilization/fixation test logs, pre-stabilization/fixation test logs, and the "paint filter test" logs, a data bank would be compiled that would serve as a basis for administrative decision and control and operation of the process for each type of waste or waste mixture to be processed to assure achievement of a product suitable for landfilling.

The operation of transferring liquid waste from the sumps or from tank trucks to the batch tanks is controlled with the use of the site waste movement forms, as described above. In addition, at the tank truck fill station, the administrative control measure of individually keyed locking caps is employed as discussed in the Tank Farm Section D-4e.

The process controls on the system can be grouped into equipment protection controls and feed controls to achieve specified mixture formulations. The equipment operation controls are automatic functions interlocking to shut-off motors, pumps or mixers to automatically protect the equipment from damage. The feed controls require operator adjustment.

The process control for setting waste to stabilizing/fixing additive mixture formulation consists of variable drives on the additive hopper feed screws and throttling valves on the liquid feed lines from the batch tanks. These controls are local and accessible to the operator from the personnel walkways at the respective equipment. It is intended to vary the additive hopper feed screw drive speeds and the liquid feedrate, if feeding liquids, around a preset sludge/solids feedrate from the belt conveyor. The variable speed controller on the belt conveyor is intended for adjustments based on actual sludge/solids density, not for adjustments to vary formulation ratios. All screw conveyors and the pug mill feed screw operate at single speeds suitable for transporting materials adequately over the variable feedrate ranges.

In addition, the lime feed to the batch tanks is a manual control loop for pH conditioning of the liquid waste in the batch tank. If necessary, to achieve the pH conditions discussed in Section D-9c(2) favoring the "pozzolanic" process, lime would be added to the tanks from the recirculating lime slurry system. Local pH indication is provided at the tanks along with high pH level alarm.

The equipment protection controls on the batch tanks are: high level alarm and shut-off of the feed pumps at the Tank Farm and low level alarm and shut-off of mixers and discharge pumps.

The low level alarm and pump/mixer shut-off is intended to both protect the equipment and alert the operator to make a decision as to whether an additional batch of the same liquid waste should be transferred from the Tank Farm Storage/Treatment Tanks or the batch tank should be emptied by use of a deadman switch on the pumps.

Speed monitoring instrumentation is provided on the motors driving all the screw conveyors, the belt conveyor and the pug mill screw feeder. These serve to shut down the entire system, including any liquid on low speed at any motor reflective of plugging of the screw by the material being transported. Specifically, this shut-down is to be performed in reverse sequential order from the discharge conveyor, i.e., sequential shut-down in reverse to assure discharge of the waste inventory in the conveyors and pug mill. High temperature monitoring is provided on pug mill to shut down the system in the above same manner in the event of an excessive heat generation due to an improper neutralization reaction.

The procedures for responding to these circumstances are described in Section G, Contingency Plan and Emergency Procedures.

D-9c(a)b Operating Procedures Outline. The following outlines operating procedures for start-up, shut-down and batch tank filling and conditioning. This outline is not intended to serve as operating procedures; actual procedures would be developed during equipment purchase and construction, along with the associated operator log sheets. Manual operating steps are employed extensively to require the operator to interact with the processing, thereby introducing further administrative control.

Start-Up

Prior to start-up, the following prechecks shall be performed:

- Waste movement forms have been completed indicating the volume of wastes to be processed;
- Stabilization/fixation formulations have been specified;
- Liquid wastes, if any, mixers in the batch tanks are active, any feeding to the tanks has ceased, and the pH is in the range 6.5 to 11;
- Sufficient stabilization/fixation additive(s) are available;
- All associated alarms are operative;
- Truck(s) for removal of discharge are available;
- The front-end loader is operable and active; and
- The laboratory is prepared to test the initial batch per the "paint filter test".

The stabilization/fixation additive(s) are then transferred from the hoppers to the local receivers. The formulations ratios are set at the batch tank discharge and the receiver screw feeds; these formulations are set around a fixed sludge/solids feedrate from the belt conveyor.

All conveyors and screw feeders are then set active including the chemical additive auxiliary conveyor, if necessary. The belt conveyor speed is adjusted if the sludge/solids consistency varies significantly from the previous operations setting.

Stabilization/fixation additive feeding is started just prior to sludge/solids or liquid feeding to assure a mixture is discharged. Samples are composited from the initial discharge and subjected to paint filter test.

Shut-Down

When liquid wastes are being processed and the low level interlock alarms and shuts down the mixers and discharge pumps, or the waste inventory to be stabilized/fixed has been completely processed, manual shutdown is performed.

Shut-down is performed in a manner to empty the pug mill, conveyors and batch tanks so as to reduce residual holdup that could cake upon equipment surfaces requiring down-time for cleaning.

Where liquids are being processed and the batch tanks have shut down, the system shall be shut-down while the operations personnel evaluates if additional liquid wastes shall be transferred to the batch tanks.

The feeds are shut down first, all sludge/solids are removed from the tipping area and belt conveyor feeder hopper. Processing can continue without liquid feed sufficient to discharge this residual material.

Conveying equipment is shut down in the following order: belt conveyor, auxiliary conveyor, pug mill feed transfer conveyor, pug mill and discharge conveyor.

Were a batch to not pass the "paint filter test", the system would be shut down in accordance with the above-outlined procedures. The discharged material would then be delivered to the tipping area or sediment pit for reprocessing if it exhibited a liquid content requiring dewatering.

Visual inspection would serve to provide advance warning of a batch not appearing to have consistency suitable to pass the "paint filter test".

Batch Tank Filling and Conditioning

Prior to batch tank filling, the following prechecks shall be performed:

- Waste movement forms have been completed indicating the volume of waste to be processed and assuring compatibility
- Mixer and vent blower active
- Associated alarms are operable.

Valving is then aligned between the Tank Farm Storage/Treatment Tank tank, tanker truck or liquid pit. All other transfer line valving is closed to prevent backflow or any vapors. With the transfer pump active, the operator monitors the tank level indicator. Prior to activating the transfer pump, the inventory to be transferred is checked against available capacity; where filling is from tanker truck or liquid pit, an estimate of the transfer pumping time is established as a check. Monitoring of the truck meter is also employed to prevent overfilling.

Prior to batch tank conditioning, the following prechecks shall be performed:

- Verify the inventory of lime slurry in lime slurry tank T-14;
- Mixer active in lime slurry tank and system is on recirculation mode; and
- pH indication instrumentation and alarm active, flush if necessary.

Subsequent to inspection of the pH of the waste being treated and determination of the estimated volume of lime required for conditioning, the three-way valve on the recirculation system is set to bleed in lime. Consideration shall be given to the type of lime utilized in the lime slurry tank; high calcium hydrated lime will result in more rapid neutralization, while dolomitic lime will require a lag time of up to half an hour prior to recording pH change. In any event, the lime slurry addition would be performed in batches. Both the leveling out of the typical buffer curve and the high level pH alarm would provide operational flexibility to prevent pH adjustment over 11.

D-9d <u>Materials Handling</u>

The following section describes the stabilization/fixation additives and sludge/solids storage, handling and conveying. Quality control procedures for additives are also discussed.

D-9d(1) <u>Sludge/Solids Handling</u>. The sludge/solids are to be delivered by dump trucks in 10 cubic yard loads, to the Stabilization/Fixation Facility through the northeast truck bay (see figure drawing B511-D-BC-20 through 22). The trucks will drop the load onto the tipping area floor where a front-end loader will serve to feed the sludge/solids into the belt conveyor feed hopper.

The feed hopper rests over the belt conveyor and is designed with a side feeding chute with an adjustable damper to assist in uniform feeding to the belt conveyor (see drawing B5611-D-M22 for detail). Conveyor bottom pulley assembly rests over the conveyor pit to allow for the belt to be fed at grade and to contain any residuals spillage.

This arrangement protects the belt conveyor from receiving dropped loads directly, potentially overburdening and damaging it. In addition, the front-end loader will provide a materials checkpoint; large objects would be set aside for special handling.

The floor dimensions of the tipping area are approximately 16-1/2 feet wide by 24 ft long. The clearance over the tipping area extends to the roof. The truck bay height is 30 ft. An additional four foot by 16-1/2 foot triangular area extends off the feed hopper.

This area and the roof clearances are sufficient for the trucks to back in partially, raise the bed for unloading and drive out while leaving an area for the load and front-end loader maneuvering. The feed hopper has doors that extend out to the concrete barriers which serve to both contain the sludge/solids and protect the building structure from the truck traffic. Cement-filled pipe posts are located around the exterior of the building columns at the truck bays and the stairs and columns exposed in the interior for the same reasons.

The sludge/solids belt conveyor has cleats and sidewalls to facilitate conveying and is covered with a shroud after the feed hopper area.

The discharged stabilized/fixed solids drop off the discharge conveyor through a flex duct over the discharge area truck bay. This truck bay has a clearance of approximately 21 feet suitable for dump trucks with the bed in the down, load position.

D-9d(2) Stabilization/Fixation Additives Storage and Handling. The stabilization/fixation storage and transfer systems consists of three bulk storage silos located on the southern wall of the Stabilization/Fixation Facility building, each with pneumatic transfer to three receivers dropping to screw feeders overhead of the pug mill feed transfer conveyor (see drawing B511D-SK25 for system diagram). The use of three bulk storage silos and receiver hoppers allow for segregation of fly ash, cement kiln dust and dry limestone. The bulk silos have capacities of 80, 100 and 80 cubic meters, respectively. Larger capacity is provided for cement kiln dust, as this is expected to be the primary additive used for stabilization/fixation. The bulk storage silos are to be filled from pressure differential trucks, which will pneumatically convey their load into the silos. The silo capacities are approximately one-third over capacity to the typical truck load of 60 cubic meters (2,000 cubic feet). The bulk silos have redundant level indicators.

Pneumatic transfer to the receiver hoppers is proposed. The pneumatic transfer of additives from the bulk silos to the receivers is to be performed by the use of blow tanks which fluidize batches of material under pressure, then on release of pressure, the suspended holdup is delivered to the receivers. The sequence is automatically controlled. This arrangement is more dependable and is expected to require less maintenance for these abrasives than the alternative rotary valve-pneumatic conveying. Level transmitters at the receivers interlock with the blowers to start-up or shut down the transfer on empty or full receivers.

Clumping and bridging is prevented by the use of vibrating bins dropping to the blow tanks on the silos and to the screw feeders on the receivers. In addition, the air delivered to the dust control fabric filters overhead each of the silos and receivers is dried to prevent moisture absorption and plugging of these vents. The blowers on the pneumatic transfer systems would introduce a sufficient temperature rise to vaporize any moisture in the transfer air.

The stabilization/fixation promoting chemicals (granular sodium silicate or polymer additives), if necessary, would be purchased in the 50 or 100 pound bags and be stored on the 34 foot elevation platform in the vicinity of the chemical additions auxiliary conveyor. The anhydrous form ($Na_2\ SiO_3$) of sodium silicate should be used when this additive is desirable.

D-9e Equipment Description

This section describes the primary equipment items. Tables are included summarizing the fabrication and design specifications. A discussion of major process equipment follows. The equipment arrangement drawing series provides an overview of size and location of these equipment items (Drawings B511-BL20 to BL22).

D-9e(1) Inclined Sludge/Solids (Belt) Conveyor C-1. The Stabilization/Fixation Facility system will have an inclined belt conveyor to transfer sludge/solid wastes to be stabilized/fixed to the pug mill. Table D-9-1 provides a summary of the fabrication and operating specifications. Drawing B511-D-M20 (Outline - Inclined Solids Conveyor C-1) provides a mechanical depiction of the unit. Section 6040, subsection 2.01, of the technical specifications provides detailed specifications for this item.

The belt conveyor extends 32 feet from the front-end loader feed hopper at grade elevation, where it is seated in the conveyor sump, to the pug mill feed hopper located at the intermediate platform on elevation 27 feet.

Just above the front-end loader feed hopper, the belt is entirely enclosed by a shroud.

The conveyor is inclined at approximately a 2 on 1 slope.

The materials of construction are as follows: structural components are carbon steel; belt housing and shroud are galvanized steel; the belt is oil-resistant rubber.

The 2' wide belt has 3-1/2" cleats and a 4" flexible sidewall to facilitate the sludge/solids transfer. The belt is driven by a variable speed five horsepower explosion-proof motor acting on the head pulley to provide a maximum 270 foot per minute belt travel. Lubrication fittings are provided for idlers and pulleys.

D-9e(2) Screw Conveyors. The Stabilization/Fixation Facility system employs three (3) screw conveyors to transport solids; the pug mill feed transfer conveyor C-2, the chemical additions conveyor C-3, and the pug mill discharge conveyor C-4. These items are depicted on drawings B511-D-M21 and M22 and specified in section 6040, subsection 2.02, of the technical specifications. Tables D-9-2 through D-9-4 summarize the fabrication and operating specifications for these conveyors.

TABLE D-9-1

PROPOSED INCLINED SLUDGE/SOLIDS CONVEYOR (C-1)

| | |
|---|---|
| Conveyor C-1: | Belt Sludge/Solids conveyor |
| Design Functions: | Inclined conveyor for sludge/ solids feed to pug mill |
| Materials of Construction: | Belt: oil resistant rubber (with cleats and sidewalls)<br>Covers: galvanized steel<br>Structure: carbon steel |
| Fabrication Standards: | See Section 6040 of Stabilization/Fixation Facility technical specification |
| Dimensions: | 4'-6" x 32'4", 2' wide belt (see drawing B511-D-M20) |
| Capacity: | Design: 3 tons/hour<br>Maximum: 5 tons/hour<br>(100 cubic foot/hour of maximum 100 pound/cubic foot, 60-70% moisture material) |
| Power: | 5 hp - 270 rpm |
| Location: | Elevation 0 to 20' |

TABLE D-9-2

PROPOSED PUG MILL SCREW CONVEYOR (C-2)

| | |
|---|---|
| Conveyor C-2 | Screw Pug mill feed transfer conveyor |
| Design Functions | stabilization/fixation additives transfer from receivers to pug mill |
| Materials of Construction | 316L SS |
| Fabrication Standards | See Section 6040 of Stabilization/Fixation Facility Technical Specification |
| Dimensions | 1'-2" x 14'10", 9" diameter screw (see drawing B511-D-M20) |
| Capacity | Design: 7.5 tons/hour<br>Maximum: 11.25 tons/hour<br>(300 cubic foot/hour of maximum 75 pound/cubic foot material) |
| Power | 3 hp - 60 rpm |
| Location | Elevation 20' |

TABLE D-9-3

PROPOSED CHEMICAL ADDITIONS CONVEYOR (C-3)

| | |
|---|---|
| Conveyor C-3: | Screw conveyor |
| Design Function: | Manual feed at additives chemical additives |
| Materials of Construction: | 316 SS |
| Fabrication Standards: | See Section 6040 of Stabilization/Fixation Facility Technical specification |
| Dimensions: | 1'-2" x 7'-10", 9" diameter screw (see drawing B511-D-M21) |
| Capacity: | Maximum: 3.7.5 tons/per hour (100 cubic foot/hour of 75 pounds/cubic foot material) |
| Power: | 0.5 hp - 25 rpm |
| Location: | Elevation 34' |

TABLE D-9-4

PROPOSED PUGMILL DISCHARGE CONVEYOR (C-4)

| | |
|---|---|
| Conveyor C-4: | Screw conveyor |
| Design Function: | Transfer of stabilized/fixed material from pugmill discharge to landfill truck overhead position |
| Materials of Construction: | 316 L SS |
| Fabrication Standards: | See Section 6040 of Stabilization/Fixation Facility Technical specification |
| Dimensions: | 1'-5" x 19'-11", 12" diameter screw (see drawing B511-D-M22) |
| Capacity: | Design: 12 tons/hour maximum capacity: 15 tons/hour (300 cubic foot/hour of maximum 100 pounds/foot material) |
| Power: | 5 hp - 30 rpm |
| Location: | Elevation 20' |

The screw conveyors are all fabricated of 316L stainless steel. The screw are standard pitch, solid flight, right-hand orientation. Bronze bearings with external lubrication fittings are employed. The screw diameters are 9", excepting the discharge conveyor which as a 12" screw for the higher duty service.

The covers are flat bolt on and are provided with a limit switch at the discharge end to serve as a relief lid safety mechanism.

The conveyors are belt-driven by explosion-proof motors of capacity 1/2 horsepower for the auxiliary conveyor C-3, 3 horsepower for the additives conveyor C-2, and 5 horsepower for the discharge conveyor C-4.

D-9e(3) Pug Mill PM-1. The proposed pug mill is an all-welded and machined, skid-mounted unit, intended to be purchased as a pre-designed unit from a specialty vendor. Table D-9-5 summarizes the fabrication and operating specifications for these conveyors.

The unit is a horizontal, stationary shell, solids/liquids mixer with a rotating rotor. The rotor is a shaft with 3/4" diameter pins extending from it for a total 3' outer diameter. A constant speed feed screw, driven by a 3/4 horsepower motor, feeds the solids/sludges additives into the mill. Liquid feeds enter through a pipe in the shaft housing, overhead of the rotor. The overall unit is driven by a 15 horsepower motor to achieve 600 rpm. The shaft is supported by roller bearings at either side, outfitted with lubrication fittings.

The shaft on the housing is lined with a 1/2" thick, resilient, wear-resistant polyurethane based lining. The pins, which will have the most contact with the feeds, are constructed of an abrasion-resistant alloy with tungsten carbide tips.

The shaft and all other items that contact the feeds are constructed of heat-hardened steel for abrasion-resistance. The 1/16" clearance between the pin tips and the housing prevent buildup of material and reduce the holdup to an amount readily discharged during the winding down of the motor on shutdown. The shaft housing has a bolted on cover fabricated in sections for ease of removal for inspection or cleaning of the shaft.

The pug mill is specified in section 6050 of the Stabilization/Fixation Facility technical specification.

The pug mill is located on elevation 20', entirely within the Stabilization/Fixation Facility building, wherein any spillage would be contained.

D-9e(4) Bulk Storage Silos and Receivers. The three bulk storage silos, S-1, S-2 and S-3 provide for bulk storage of the stabilization/fixation additives. The capacities of the fly ash (S-3), cement kiln dust (S-2) and dry limestone silos, are 80, 100 and 80 cubic meters, respectively.

The silos, pneumatic transfer system, and receivers are intended to be purchased as a pre-designed system from the materials handling/storage specialty vendors. This proposed system is depicted on drawing B511-D-SK25. Table D-9-6 summarizes the fabrication and operating specifications for the silos.

The silos are to be constructed of welded or bolted mild steel with a primer and external coat of paint. The diameter of all three silos is 12 feet, while the heights are 24 feet for the 80 cubic meter silos S-1 and S-3, and 32 feet for the 100 cubic meter silo S-2. The silos are erected above dedicated 50 cubic foot blow tanks, each served by a 30 horsepower motor. Pneumatic transfer is automated to sequence as follows; slide gate valve opens to drop material to blow tank, blow tank is pressurized to fluidize material, butterfly valve opens causing blow tank holdup to transfer to receivers. This sequence is continued until the high level switch on the receivers shut off the blowers.

The silos are completely outfitted with access manholes, top and side-mounted level indicators, continuous cleaning pulse jet design filter

TABLE D-9-6

PROPOSED STABILIZATION BULK STORAGE SILOS S-1, S-2, S-3

| | |
|---|---|
| Silos S-1, S-2, S-3: | Vertical bulk solids silos |
| Design Function: | Bulk storage of fly ash S-3 cement kiln dust S-2, dry limestone S-3 |
| Materials of Construction: | Mild steel with primer and exterior coat, welded or bolted construction |
| Fabrication Standards: | See Section 6010 of Stabilization/Fixation Facility Technical specification |
| Dimensions: | 12' diameter, 24'long for S-1 and S-3, 32'long for S-2; conical bottom. (see drawing B511-D-T22r |
| Capacity: | S-1 and S-3, 80 cubic meters S-2, 100 cubic meters |
| Location: | Elevation 0' |
| Transfer and Dust Control Accessories | Pneumatic transfer by line bottom bins to 50 cubic feet blow tanks; blower - 30 hp. Bon vent filter using filter tubes and continuous cleaning pulse jet design |

tube bin vent filters for dust control, and live bottom bins for feed to blow tanks. Bin vent filters are fed dry compressed air to prevent clogging of the dust control vents.

All silos are filled by pressure differential truck through individually keyed locked caps adjacent to the Stabilization/Fixation Facility building near the silos. The silos are capable of holding approximately one and one-third volume of a truck, allowing for filling of a one-third full silo.

All silos, including the fly ash silo, are contained within the Stabilization/Fixation Facility floor slab with its curbing for spillage containment. The lower sections of the silos are enclosed in the Stabilization/Fixation Facility structure. The silos are accessed either at the grade level directly, at elevation 20 by the stairs leading around the silos on the root extension platform. Ladders extend up the silos for access to the top. The silos are supported by the Stabilization/Fixation Facility building's steel structure.

An outline of the silos is provided in drawing B511-D-T22. The enclosure and location of the silos is depicted in drawing B511-D-A21.

The stabilization/fixation additive receivers, T-10, T-11 and T-12, serve as local hoppers to provide an operating holdup over the additives feed conveyor. The capacity of each of the receivers is 75 cubic foot. The units are round vertical hoppers with conical bottoms, constructed of welded carbon steel with live bottom bms. The additive drops to a variable rate screw feeder, where the processing additives feedrate is set, which in turn drops to the pug mill additives feed conveyor C-2.

Each receiver is outfitted with bin vent filters with the same filter tube and continuous cleaning pulse jet design as the bulk storage silos.

The receivers are located on the intermediate platform at elevation 27 feet, which serves to provide access to their feeding mechanisms. The receivers, including the fly ash receiver, are located entirely within the

Stabilization/Fixation Facility building, and as such, any possible spillage would be contained by the building curbing. Table D-9-7 summarizes the technical and operating specifications for the receivers.

D-9e(5) Batch Tanks. The two batch tanks, T-9 and T-13, serve to provide a local quantity of waste liquid for processing. Both tanks have 2,000 gallons capacity and can be filled from their respective compatible waste feed storage tanks in the Tank Farm Storage/Treatment Facility, from the liquid pit in the building or from a tanker truck if special waste handling is needed.

The batch tank system is depicted on drawing B511-D-SK24 and summarized in Tables D-9-8 and D-9-9.

Two tanks are provided to segregate the waste liquid feeds according to equipment fabrication material suitability and compatibility. T-9, serving to hold batches of solvents, oils and oil sludges in a 316L stainless steel vessel. T-13, serving to hold batches of aqueous waste and neutralized solutions of alkali and acid wastes delivered from the Tank Farm Storage/Treatment Facility's neutralization tank (T-3), is constructed of FRP.

Tank T-9 is to be fabricated in accordance with ASME Boiler and Pressure Vessel Code Section VIII for 15 pounds pressure as indicated on Drawing No. B511-B-T20. The calculated minimum wall thickness for the tank, assuming waste liquid contents of specific gravity 1.5, is 1/4 inch (see calculations in Appendix D-9.3).

Tank T-13 is to be fabricated in accordance with the applicable FRP code, ASTM D40-97 as indicated on Drawing No. B511-B-T21. The calculated minimum wall thickness for the tank, conservatively assuming waste liquid contents of specific gravity 1.5, is 1/4" and 3/8" for the dished bottom (see calculations in Appendix D-9.1).

These tanks are double-walled, with the second wall to serve as secondary containment. Liquid sensors in the annular space will alarm to

TABLE D-9-7

PROPOSED STABILIZATION/FIXATION ADDITIVES
RECEIVERS T-10, T-11, T-12

| | |
|---|---|
| Receivers T-10, T-11, T-12: | Vertical batch operation hoppers |
| Design Function: | Provide local stabilization/fixation additive holdup for processing. Feed to additives feed conveyor |
| Materials of Construction: | Carbon steel, all welded |
| Fabrication Standards: | See Section .6010 of Stabilization/Fixation Facility Technical specification |
| Dimensions: | 4' diameter, 7 1/2 long conical bottom |
| Capacity: | 75 cubic feet |
| Location: | Intermediate platform at elevation 27' |
| Transfer and Dust Control Accessories: | Live bottom bin to screw feeders (5 tons/hour for T-11 and T-12, 2.5 tons (hour for T-10). Bin vent filter using filter tubes and continuous cleaning pulse jet design |

TABLE D-9-8

PROPOSED BATCH TANK T-9

| | |
|---|---|
| Tank No. T-9: | Batch tanks for solvents, oil sludge, oil |
| Design Function: | Provide for local holdup and conditioning of waste liquids to be stabilized/fixed (e.g. 1.0) |
| Materials of Construction: | 316 SS |
| Fabrication Standards: | ASME Boiler and Pressure Vessel Code Section VIII |
| Maximum Pressure: | Atmospheric/design 15 pounds per sq. inch |
| Shell thickness: | a minimujm 1/4 inch |
| Corrosion Allowance: | 1/32 inch |
| Capacity: | 2,000 gallons |

TABLE D-9-9

PROPOSED BATCH TANK T-13

| | |
|---|---|
| Tank No. T-13: | Batch tanks for aqueous waste, solutions neutralized of the alkali and acid wastes |
| Design Function: | Provide for local holdup and conditioning of waste liquids to be stabilized/fixed (e.g. 1.5) |
| Materials of Construction: | FRP |
| Fabrication Standards: | ASTM D40-97 |
| Shell thickness: | 1/4 inch, 3/8 inch bottom shell |
| Corrosion Allowance: | 10-20 miles synthetic surfacing mat (e.g. Dynel) |
| Maximum Pressure: | Atmospheric |
| Capacity: | 2,000 gallons |

indicate any leakage of the tank contents. The jacket and sensor act as a dedicated leak detection system on the tanks. Drainage is provided through the outer wall to allow for controlled collection of leakage. The tank would be taken out of service for repair in the event of detecting a leak.

## D-9f Spill Containment

The Stabilization/Fixation Facility design incorporates spill containment capacity. A complete perimeter system of curbs and ramps surrounds the facility and interior drainage is controlled by floor drains and sumps.

Keyed into the grade slab is a six-inch curb, installed with water stop. At the truck bays and personnel exits, a six-inch ramp is provided.

The grade slab is epoxy-coated, diked and sloped to floor drains draining to a sump. The batch tanks have dedicated secondary containment in the form of the double-walled tanks described in Section D-9e, above.

The grade slab plan is depicted on drawing B511-D-F21, with the curbing, ramp and other details shown on B511-D-F22. The surface is to be coated with a total 40 mils epoxy. The curbs and ramping serve to contain spillage, i.e., prevent run-off and prevent run-on.

A total of four (4) floor drains are located in subsections of the floor, each sloped to direct spillage to the drain. Drainage piping is to be HDPE pipe connected to the sump pit. The truck sludge/solids unloading area has a drainage ditch routed directly to the sump.

The sump design is a baffled pit with a grated cover depicted on drawing B511-D-F23. The maximum total capacity of the pit is approximately 3,500 gallons.

The grating cover, and use of grating for the building elevation walkways allows for any spillage from the upper floors to drop down to the floor drains or directly to the sediment/liquid pit.

The design is intended to promote the separation of the liquid fraction of any spillage to allow this material to be pumped to the batch tank for stabilization/fixation. In addition, this arrangement allows for clarification of a waste sludge load, if necessary. These flow paths are depicted on Drawing B511-D-SK26, stabilization building P&I diagram. All waste movements from trucks into the pit or pumped out of the pit would be handled similar to any waste intended for stabilization/fixation processing as discussed in Section C.

The design of the sediment/liquid pit incorporates an HDPE lining, below the epoxy coated concrete surface, along with sampling wells constructed in the leak drainage section. This overall design results in a double barrier against leakage from the pit, which with inspection per Section F, will serve as a leak detection system. Thus, the sump system has been designed to meet Part B standards.

## D-9g Personnel Safety/Fire Protection

Personnel safety protection has been included in the overall design of the Stabilization/Fixation Facility. This includes fire protection, eyewash/shower stations and walkway/exit designs facilitating emergency evacuation.

Fire protection is provided by a sprinkler system, dry chemical fire extinguishers, flammable gas detectors, and fire hose cabinets. These items and their locations are depicted on the equipment arrangement drawings B511-D-BL20 and BL21.

A sprinkler system is to be installed over the pug mill equipment area. Two extinguishers are located at readily accessable locations on each of the three elevations; total 6. Flammable gas detectors/alarms are situated in the vicinity of the batch tanks and in sediment and conveyor sumps. In the latter locations they serve to alert personnel to any unnoticed holdup of solvent spills. The fabrication and installation of the fire protection system devices is specified in Section 6060 of the Tank Storage/Treatment facility.

In addition, equipment motors are protected from spark generation by an explosion-proof (NEC class 1, division 1, group C) specification on the latter).

Four (4) eyewash/shower stations, fed from the dedicated water tank system described in Section D-4 of the Tank form, are located at personnel traffic locations. Two are on the grade elevations, at the truck bay and to the rear of the sump, and one is on each of the other two levels at the stairwell exits. Drawings B511-C-P2 provides a detail of the eyewash/shower stations.

# APPENDIX D-9.1

## STABILIZATION/FIXATION FACILITY

## Tank Calculations

Proteco, Inc.
Structural Calculations - Batch Tank
Dwg. # 8511-D-T20

Allstates Design &
Development Co., Inc.
One Oxford Valley, Suite 609
2300 East Lincoln Highway
Langhorne, PA 19047

A. Ziegler 1-30-86

T-9 Organic Batch Tank

S.G. = 1.5

Dia = 7'-0"
Straight Hgt = 7'-0"
Working Capacity = 2,000 gallons

Mat'l 316L SS

Design requirements are based on ASME Boiler and Pressure Vessel Code Section 8, Paragraph UG-27 "Thickness of Shells Under Internal Pressure."

The minimum thickness of cylindrical shells shall be the greater thickness as given by (1) or (2):

$$(1) \quad t = \frac{PR}{SE - 0.6\,P}$$

$$(2) \quad t = \frac{PR}{2SE + 0.4P}$$

Where:

t = minimum required thickness of shell, in.
P = design pressure, psig
R = inside radius of shell, in.
S = max. allowable stress value, psi
E = joint efficiency

Use a joint efficiency, E = 0.7 (from part UW-12).

S = 25,000 psi (from table UHA-23).

Using a design pressure of 15 psi:

$$(1) \quad t = \frac{15 \times 42}{25{,}000\,(.7) - 0.6\,(15)}$$

$$t = 0.036"$$

$$(2) \quad t = \frac{15 \times 42}{2\,(25{,}000)\,.7 + 0.4\,(15)}$$

$$t = 0.018"$$

The minimum required wall thickness using the ASME pressure vessel calculations with a 15 psi internal design pressure is 0.036".

However, due to external loading and rigidity considerations the tank minimum shell and head thickness should be 1/4".

Dwg # 8511-D-T21

T-13 Aqueous Batch Tank s.g. = 1.5

Dia. = 7'-0" (84")
Straight Hgt. = 7'-0" (84")
Working Capacity = 2,000 gallons

Design requirements are based on ASTM D4097-82, Section 6:

Straight shell wall thickness:

$$t = \frac{0.036\,\gamma\, HD}{2S_h}$$

where:

- $t$ = wall thickness, in.
- $S_h$ = allowable hoop tensile stress
- $p$ = pressure, psig
- $H$ = fluid head, in.
- $\gamma$ = specific gravity
- $D$ = inside dia. of tank, in.

t = [redacted] (84)

t = 0.127" < 3/16"

According to ASTM D4097, the straight shell wall thickness shall not be less than 3/16". Therefore, use 1/4" wall thickness.

Top Head - From ASTM D4097, Section 6.2.1: The minimum thickness of the top head shall be 3/16 in. Use 1/4"

Elevated dished bottom thickness:

From ASTM D4097 Section 6.3.4

Dwg. # B511-D-T21 cont'd.

$t = 0.885\ (0.036\ \gamma\ HR)/S$

$t = 0.885\ [0.036\ (1.5)\ (108 \times 84)]\ /\ 1500$

$t = 0.289"$ use 3/8" bottom thickness.